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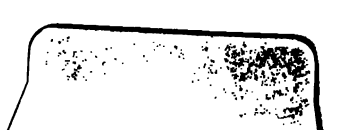
THE CHEMICAL PROCESSES OF THE BRITISH PHARMACOPŒIA,

HENRY J. CHURCH.



THE CHEMICAL PROCESSES OF THE BRITISH PHARMACOPEIA,

AND

THE BEHAVIOUR, WITH RE-AGENTS, OF THEIR PRODUCTS.

BY

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THE intention of this book is to give, as concisely as possible, the *rationale* of every special chemical process of the British Pharmacopeia, and to point out the behaviour, with re-agents, of the several resulting compounds. As it is highly important that the student of Pharmacy should thoroughly familiarize himself with both these subjects, it is hoped that the present Manual will afford him considerable assistance. It makes no attempt at criticism, nor is it put forth as a practical guide for the laboratory: too many "critical remarks" have probably been already made upon the Pharmacopeia; and to those in quest of a work on laboratory practice, "*Wittstein's Practical Pharmaceutical Chemistry, by Darby*," may be highly recommended.

Cambridge,
June, 1864.

THE CHEMICAL PROCESSES OF THE BRITISH PHARMACOPEIA.

ACIDUM ACETICUM GLACIALE. *Glacial Acetic Acid. Monohydrated Acetic Acid,* $HO, C_4H_3O_3$.

Twenty ounces of Acetate of Soda are fused in a porcelain basin, the mass broken up and placed in a three-pint retort connected with a Liebig's condenser. Eight fluid ounces of Sulphuric Acid are added, and when the distillation of Acetic Acid begins to slacken, a gentle heat is applied until six fluid ounces are obtained.

One equivalent of anhydrous Acetate of Soda is decomposed by two eq. of Sulphuric Acid, Acetic Acid and Bisulphate of Soda resulting:

$$NaO\ C_4H_3O_3 + 2HO\ SO_3 = NaO\ 2SO_3 + HO, C_4H_3O_3 + HO.$$

If impure Acetate of Soda be employed, the Sulphuric Acid, acting upon its impurities (extractive &c.) will give rise to Sulphurous Acid, and thus contaminate the product. The presence of this is ascertained by Solution of Iodate of Potash and Starch. Should re-distillation be necessary, Black Oxide of Manganese is first mixed

with the impure Acetic Acid. Hyposulphate of Manganese is produced by the combination of Peroxide of Manganese with Sulphurous Acid, and, on re-distillation, remains in the retort.

ACIDUM ARSENIOSUM. *Arsenious Acid.* *As* O_3.

Commercial White Arsenic is sublimed by heat: the sublimate is pure Arsenious Acid. The heat required is that of about 360°; Sulphates of Lime and Baryta, which are the usual adulterations, remain behind.

ACIDUM BENZOICUM. *Benzoic Acid. An acid,* HO, $C_{14}H_5O_3$, *obtained from Benzoin by sublimation.*

Gum Benzoin is placed in a flanged cylindrical pot of sheet iron, to which a cylinder of stiff paper is adapted. Sufficient heat to melt the Benzoin is applied, and continued for six hours. The product, if not quite white, is to be pressed between folds of filtering paper and re-sublimed.

Good Benzoin contains from twelve to twenty per cent of Benzoic Acid—together with resin, volatile oil, &c. When heated, the Benzoic Acid and Volatile Oil are both thrown off. In some processes the latter is detained by placing a sheet of blotting paper over the mouth of the vessel containing the Benzoin, that is to say, between it and the paper cylinder. The presence of a trace of this Oil is of no importance, but on account of

the acid some such interposition is necessary. A great heat must be guarded against, otherwise the Benzoic acid becomes mixed with empyreumatic products.

ACIDUM CITRICUM. *Citric Acid. An acid,* $3HO, C_{12}H_5O_{11} + HO$, *obtained from Lemon juice, or from the juice of the fruit of Citrus Limetta Risso, the Lime.*

Four pints of Lemon juice are mixed with two fluid ounces of yeast, and set aside for two days, at a temperature of between 60° and 70°. Fermentation having ceased, the clear liquid is separated, and neutralized with Prepared Chalk. The deposit is collected, well washed with hot water and mixed with two pints of Distilled Water; and afterwards with two fluid ounces and three fluid drachms of Sulphuric Acid, previously diluted with a pint and a half of Distilled Water. This mixture is boiled for half an hour, filtered, and the filtrate concentrated to the density of 1.21. It is then cooled, set aside for twenty-four hours, and the crystals of Sulphate of Lime having been removed, again evaporated and crystallized.

The quantity of Citric Acid contained in Lemon Juice is about ten ounces per gallon. To get rid of the mucilaginous substances also in the juice, the process of fermentation is employed. The clear liquor resulting is neutralized by Chalk,

(Carbonate of Lime, CaO, CO_2), and the mixture boiled; Carbonic Acid is thus evolved, and an insoluble Citrate of Lime formed. When to this Sulphuric Acid is added, Sulphate of Lime is produced and almost entirely deposited, Citric Acid being set free and left in solution. The solution is now evaporated to a density of 1.21, a point at which the Sulphate of Lime crystallizes out, leaving pure Citric Acid to be obtained in crystals by further evaporation.

ACIDUM GALLICUM. *Gallic Acid. An acid* $3HO, C_{14}H_3O_7+2HO$, *prepared from Galls.*

One pound of coarsely powdered Galls is placed in a porcelain dish, and as much Distilled Water poured on them as will convert them into a thick paste. This is kept at a temperature of between 60° and 70° for six weeks, adding Distilled Water from time to time to supply what is lost by evaporation. The paste is then boiled for twenty minutes with forty-five ounces of Distilled Water, strained, cooled, and the crystalline deposit drained, pressed between folds of filtering paper, and re-dissolved in ten ounces of boiling Distilled Water. This solution is cooled to 80°, the crystals separated, washed with very cold Distilled Water, and dried at under 212°.

Galls contain only from about three to six per cent of ready formed Gallic Acid. By the Pharmacopeia process a much larger percentage is

obtained by the oxidization of their Tannin; Carbonic Acid and Water are at the same time produced. After six weeks the Tannic Acid is most of it converted into Gallic Acid, which is dissolved out by boiling. On the liquid cooling the undecomposed Tannin remains in solution; but much of the Gallic Acid is deposited in crystals on account of its less solubility in water.

Regarding the composition of Tannic Acid as $C_{54}H_{32}O_{34}$, and assuming that 24 atoms of oxygen are absorbed, the oxidizing process may be thus explained.

$$C_{54}H_{22}O_{34} + 24O = 3(3HO, C_{14}H_3O_7) + 4HO + 12CO_2.$$

ACIDUM HYDROCHLORICUM. *Hydrochloric Acid. Hydrochloric Acid Gas, HCl, dissolved in water.*

Forty-four fluid ounces of Sulphuric Acid are diluted with thirty-two ounces of water, and the mixture, after having cooled, is poured upon three pounds of dried Chloride of Sodium, in a flask able to hold at least a gallon, and connected with a three-necked bottle containing four ounces of water and supplied with a safety tube. The gas is conducted through a tube into the wash-bottle, and thence into a second bottle containing fifty ounces of Distilled Water, by means of a tube dipping about half an inch below its surface. The process is continued till the product measures sixty-eight ounces.

In this process the disengagement of Hydro-

chloric Acid Gas must be effected by heat: this the Pharmacopeia has omitted to mention. A sand-bath should be employed, and the heat applied gradually.

One eq. of Chloride of Sodium is here decomposed by two eq. of Sulphuric Acid, Hydrochloric Acid Gas and Bisulphate of Soda resulting:

$$Na\ Cl + 2HO\ SO_3 = NaO\ 2SO_3 + HCl + HO.$$

The wash-bottle detains any impurities that may pass over; the receiver must be kept as cold as possible.

ACIDUM HYDROCYANICUM DILUTUM. *Dilute Hydrocyanic Acid. Hydrocyanic Acid, HC_2N, dissolved in water, and constituting 2 per cent of the solution.*

Two ounces and a quarter of Ferrocyanide of Potassium are dissolved in ten ounces of Distilled Water, and seven fluid drachms of Sulphuric Acid, previously diluted with four ounces of Distilled Water and cooled, are added to the solution. This mixture is put into a retort, to which is adapted a receiver containing eight ounces of Distilled Water and carefully kept cold. The retort is placed in a sand-bath and subjected to a gentle heat, which is to be maintained until the contents of the receiver, increased by the distillate, measure seventeen ounces. As much Distilled Water is added to these as may be sufficient to

bring the acid to the required strength of two per cent.

Ferrocyanide of Potassium is a double salt composed of two atoms of Cyanide of Potassium, one at. of Cyanide of Iron, and three at. of Water of crystallization. When two eq. of this salt are heated with six eq. of Sulphuric Acid and some water, there are formed: three eq. of Hydrocyanic Acid, nine eq. of water, three eq. of Bisulphate of Potash, and one eq. of a salt composed of one atom of Cyanide of Potassium, with two at. of Cyanide of Iron:

$$2(FeCy, 2KCy, +3HO) + 6HO, SO_3 + xAq. = 3HCy + 9HO, + 3(KO, 2SO_3) + 2(KCy, 2FeCy) + xAq.$$

The strength of the product is estimated by treating with excess of Solution of Soda, and adding the Volumetric Solution of Nitrate of Silver.

Acidum Nitricum. *Nitric Acid*, $3HO, 2NO_5$.

Seventeen fluid ounces of Sulphuric Acid are poured upon two pounds of Nitrate of Potash in a plain retort connected with a Liebig's condenser. Heat is applied to the retort, and increased towards the end of the process to a degree sufficient to fuse its contents.

When Nitrate of Potash (KO, NO_5) is heated with about its weight of concentrated Sulphuric Acid, the latter abstracts the Potash from the

Nitrate, forms with it Bisulphate of Potash, and sets free Nitric Acid, thus:—

$KO,NO_5 + 2HO,SO_3 = (KO, 2SO_3) + NO_5 + 2HO.$

This is the theory of Nitric Acid formation. In the Pharmacopeia process, four eq. of Sulphuric Acid, spec. grav. 1.846, are accompanied by about five eq. of water, that is, one more atom of water than contained in four eq. of Monohydrated Sulphuric Acid. Hence, when these four eq. act upon two eq. of Nitrate of Potash, the result is—one eq. of Sesquihydrated Nitric Acid, and two eq. of Bisulphate of Potash:—

$2KO, NO_5 + 4HO, SO_3 + HO = (3HO, 2NO_5) + 2(KO, HO, 2SO_3).$

If, following the directions of the Pharmacopeia, a plain retort be used, such a funnel must be employed for introducing the Sulphuric Acid as will convey it into the bulb without touching the neck; the retort will else contain some Sulphuric Acid. The retort and receiver should both be large, and the latter kept very cool. At the beginning of the process the Sulphuric Acid in the retort decomposes the first formed Nitric Acid by attracting its water, and breaking it up into Hyponitric Acid and Oxygen; and the reddish brown fumes of the former, passing into the receiver, colour the product about to be formed there. Towards the end also a similar decomposition takes place, the Bisulphate of Potash

being now the cause. If, therefore, a perfectly colourless acid is required, the receiver must be changed soon after the beginning of the process, and shortly before its close.

ACIDUM PHOSPHORICUM DILUTUM. *Phosphoric Acid, $3HO\ PO_5$, dissolved in water.*

Four fluid ounces of Nitric Acid diluted with ten fluid ounces of Distilled Water, are placed in a tubulated retort connected with a Liebig's condenser, and four hundred and thirteen grains of Phosphorus added. A very gentle heat is applied until five fluid ounces of liquid have distilled over, which are returned to the retort, and the distillation renewed and continued until the Phosphorus has entirely dissolved. The contents of the retort are now transferred to a porcelain capsule and evaporated, raising the heat towards the end of the process until bubbles of orange vapour cease to form, and the liquid becomes colourless and syrupy. This liquid is, lastly, made up to a pint with Distilled Water.

A capacious retort and a sand-bath are here required. As soon as the Phosphorus is added, the action begins, and is furthered by the application of a gentle heat. The theory of the action of Nitric Acid upon Phosphorus is thus expressed:

$$3P + 5NO_5 + xAq = 3(3HO\ PO_5) + 5NO_2 + xAq.$$

that is to say, three eq. of Phosphorus and five eq. of Nitric Acid, with water, react upon each other, and form three eq. of Phosphoric Acid, and five eq. of Nitric Oxide. But practically the reaction is far more complex. It is considered that two acids, *Phosphorous* (PO_3) and *Phosphoric* (PO) are simultaneously formed in the retort, each with the evolution of Nitric Oxide. Thus, for the formation of the former, three eq. of Phosphorus are supposed to decompose three of Nitric Acid:

$$3P + 3NO_5 = 3PO_3 + 3NO_2$$

while to form the latter the reaction is this:

$$3P + 5NO_5 = 3PO_5 + 5NO_2.$$

There are thus in the retort when the process has gone on for some time but is not completed, Phosphorous and Phosphoric Acids, Nitric Acid, and Phosphorus. There have passed over, and are still passing over, Nitric Oxide, and Nitric Acid: the latter, together with some steam, is condensed in the receiver; hence the necessity for repeatedly returning the distillate to the retort. When the Phosphorus is entirely decomposed the second part of the process begins, which consists in evaporating the contents of the retort (Phosphorous Acid, Phosphoric Acid, and Nitric Acid) in order to convert the Phosphorous Acid into Phosphoric. This is effected at the expense of the Nitric Acid, which gives up part of its Oxygen and evolves

Nitric Oxide. When the orange fumes of the latter are no longer produced, the process is completed.

ACIDUM SULPHURICUM. *Sulphuric Acid. Monohydrated Sulphuric Acid*, HO, SO_3.

Twelve fluid ounces of commercial Sulphuric Acid, a quarter of an ounce of Sulphate of Ammonia, and a few slips of platinum foil, are placed in a plain retort, the upper part of which is covered with a sheet-iron hood. Heat is then applied, and after a tenth (which is to be rejected) has distilled over, a fresh flask is adapted, and the distillation continued until only a fluid ounce of liquid remains in the retort.

The retort must be able to hold at least three-times the quantity of acid to be operated upon, and it should be fixed in a sand-bath. The flask or receiver must be kept very cool, and, as the beak of the retort becomes exceedingly hot, something should be placed between it and the neck of the receiver. The platinum foil in the retort regulates the ebullition. A gentle heat is at first applied, the result of which is to bring over the water from the commercial Sulphuric Acid—hence the rejection of the first tenth. By degrees the heat is increased until the distillation proceeds rapidly. The Pharmacopeia orders this to be continued until only a fluid ounce remains in the retort; but a purer acid would be obtained by stopping the distillation when two-thirds have

passed over. The Sulphate of Ammonia decomposes any Oxides of Nitrogen that may be present, and which being volatile would else pass into the receiver. With the Oxygen of these its Hydrogen combines—Water, Nitrogen and Sulphuric Acid resulting. The common impurities of Sulphuric Acid are Organic matter, Sulphate of Lead, Hydrochloric Acid, Iron, Oxides of Nitrogen, and more rarely Arsenic.

ACIDUM SULPHUROSUM. *Sulphurous Acid. Sulphurous Acid, SO_2, dissolved in water.*

Four fluid ounces of Sulphuric Acid are put into a glass flask with one ounce of recently burned, dry, and coarsely powdered wood-charcoal. Heat is applied, and the evolved gas passed through a wash-bottle containing two ounces of water into a bottle containing twenty ounces of Distilled Water, which must be kept cold. The distillation is continued until the water will dissolve no more gas.

When Carbon is heated with Sulphuric Acid, the latter gives up an atom of Oxygen to the Carbon, thus forming Carbonic Oxide and leaving Sulphurous Acid:—

$$C + SO_3 = SO_2 + CO.$$

Both these pass into the receiving bottle, but as Carbonic Oxide is only slightly soluble in water most of it mixes with the air. The wash-bottle detains any Sulphuric Acid that may pass over.

ACIDUM TANNICUM. *Tannic Acid. An acid,* $C_{54}H_{22}O_{34}$, *obtained from Galls.*

Eight ounces of coarsely powdered Galls are introduced into a percolator, and a mixture of three pints of Ether and five ounces of Distilled Water poured in successive portions upon them. From the liquid which passes into the receiver the heavier stratum is separated and evaporated to dryness, first on a water-bath, and then in a hot-air chamber.

Here the Ether extracts the Tannic Acid, which is afterwards abstracted by the water. It is sufficiently pure, as the Ether leaves untouched the extractive of the Galls. The yield is from 25 to 50 per cent.

ACIDUM TARTARICUM. *Tartaric Acid. An acid,* $2HO, C_8H_4O_{10}$ *obtained from the Acid Tartrate of Potash.*

Forty-five ounces of Acid Tartrate of Potash are boiled with two gallons of Distilled Water, and twelve ounces and a half of Prepared Chalk added. When the effervescence has ceased, a solution of thirteen ounces and a half of Chloride of Calcium in two pints of Distilled Water is added. The Tartrate of Lime is now separated, washed, and mixed thoroughly by boiling with thirteen fluid ounces of Sulphuric Acid, first

diluted with three pints of Distilled Water. After repeated stirring the mixture is filtered, and the filtrate slowly evaporated to a density of 1.21, when it is cooled, and the crystals of Sulphate of Lime which are formed are removed. The clear liquor is now evaporated and crystallized.

Acid Tartrate of Potash consists of one atom of Tartaric Acid, one of Water, and one of Potash. When two eq. of this salt are boiled in water with two eq. of Chalk, neutral Tartrates of Potash and Lime are formed, and Carbonic Acid evolved:—

$$2KO,\ HO,\ C_8H_4O_{10} + 2CaO,\ CO_2 = (2KO,\ \overline{T}) + (2CaO,\ \overline{T}) + 2CO_2 + 2HO.$$

To convert the soluble Tartrate of Potash into Tartrate of Lime, Chloride of Calcium is employed:—

$$(2KO\ \overline{T}) + 2CaCl = (2\ CaO, \overline{T}) + 2KCl.$$

The Tartrate of Lime thus produced mingles with that first formed, Chloride of Potassium remaining in solution. Sulphuric Acid is now added to the insoluble Tartrate of Lime:—

$$(2CaO, \overline{T}) + 2HO, SO_3 + xAq. = 2CaO, SO_3 + HO, \overline{T} + Aq.$$

Most of the Sulphate of Lime subsides, only a little of it remaining in solution with the Tartaric Acid. After separating the deposit by filtration, evaporating the filtrate to 1.21, and then cooling, the Sulphate of Lime crystallizes out.

ACONITIA. *Aconitia. An alkaloid,* $C_{60}H_{47}NO_{14}$, *obtained from Aconite Root.*

Three gallons of Rectified Spirit are poured upon fourteen pounds of Aconite Root in coarse powder, the mixture heated to boiling, cooled, and macerated for four days. The whole is then put into a percolator and exhausted, by displacement, with a sufficiency of Rectified Spirit. From the tincture in the receiver most of the spirit is distilled, and the remainder is evaporated over a water-bath until the whole of the alcohol is dissipated. The residual extract is mixed with twice its weight of boiling Distilled Water, and when cold filtered through paper. To the filtered liquid a slight excess of Solution of Ammonia is added, and it is then gently heated over a water-bath. The precipitate formed is separated, dried, reduced to powder, and macerated in successive portions of Ether with frequent agitation. The several products are decanted, mixed, and the Ether distilled off until the Extract is dry. This is dissolved in warm Distilled Water acidulated with Sulphuric Acid; and when this solution is cold, Solution of Ammonia, diluted with four times its bulk of Distilled Water, is cautiously added. The precipitate formed is washed on a filter with a little cold Distilled Water, and dried by slight pressure between folds of filtering paper.

The precipitate first mentioned in this process consists of Aconitia and colouring matter. By maceration in Ether the Alkaloid is obtained free from colour, and made into a Sulphate by the addition of Sulphuric Acid. This Sulphate is lastly decomposed by Ammonia—Aconitia and Sulphate of Ammonia being formed.

Aconitia is present in Aconite Root combined with Aconitic Acid.

ÆTHER. *Ether. Oxide of Ethyl,* C_4H_5O, *with about eight per cent by volume of Alcohol.*

Ten fluid ounces of Sulphuric Acid are mixed with twelve fluid ounces of Rectified Spirit in a glass matrass capable of containing at least two pints, and, without allowing the mixture to cool, the matrass is connected by means of a tube with a Liebig's condenser, and distilled by a heat sufficient to maintain the liquid in brisk ebullition. When the Ether begins to pass over, more Spirit is poured into the matrass, and in such quantity as to equal the volume of the distillate. When fifty fluid ounces of Rectified Spirit, in all, have been added, and forty-two fluid ounces have distilled over, the process is stopped. A solution of ten ounces of Chloride of Calcium in thirteen ounces of Distilled Water—to which half an ounce of Slaked Lime has been added—is now mixed with the distillate, and the whole are well shaken together. The mixture is left at rest for ten

minutes, the light supernatant fluid then poured off and re-distilled with a gentle heat, "until a glass bead of spec. grav. 0.735 placed in the receiver begins to float." The Ether and Spirit retained by the Chloride of Calcium and by the residue of each distillation, are recovered by distillation and used in subsequent operations.

Ether being theoretically the oxide of the radical Ethyl (C_4H_5), and Alcohol the hydrated oxide of the same base, all that one has to do to obtain Ether from Alcohol, is to abstract the plus atom of Water.

The theory of Etherification is as follows:

Alcohol (AeO,HO) and Sulphuric Acid (HO,SO_3) react upon each other, forming a compound called Sulphovinic Acid, or Bisulphate of Oxide of Ethyl:

$$AeO,\ HO + 2HO\ SO_3 = AeO,\ 2HO,\ SO_3 + HO.$$

When this Bisulphate of Ethyl is heated to 285°, it boils and becomes decomposed, the Oxide of Ethyl separating from the Acid.

$$AeO,\ 2HO,\ SO_3 = HO,\ SO_3 + AeO + HO.$$

The hydrated Sulphuric Acid remains in the retort, and serves to convert further quantities of Alcohol into Bisulphate of Ethyl—which is continuously formed, and *as* continuously decomposed.

If the heat applied be far below 285° Alcohol passes over and is mixed with the Ether, as is the case in the Pharmacopeia process. If, on the

other hand it far exceed this degree, the distillate will be contaminated with empyreumatic products.

The contents of the receiver are purified by agitation with solution of Chloride of Calcium and Lime—the first of which abstracts some of the spirit that has passed over, the other any water, Sulphurous or Sulphuric Acids that may be present. The supernatant fluid, Ether, is then re-distilled.

ALUMEN EXSICCATUM. *Dried Alum.*

Alum is heated in a porcelain crucible till it liquefies; the heat is then raised and continued until aqueous vapour ceases to be disengaged.

Potash Alum (Al_2O_3, $3SO_3 + KO\,SO_3 + 24\,HO$) is deprived thus of its water of crystallization. A high degree of heat is not necessary, but rather to be guarded against, lest the salt become decomposed.

AMMONIÆ BENZOAS. *Benzoate of Ammonia.* NH_4O, $C_{14}H_5O_3 + HO$.

Three fluid ounces of Solution of Ammonia, two ounces of Benzoic Acid, and eight ounces of Distilled Water are mixed together. The solution thus obtained is gently evaporated and crystallized.

One eq. of Ammonia combines with one eq. of Benzoic Acid,

$NH_4O + HO$, $C_{14}H_5O_3 = (NH_4O$, $C_{14}H_5O_3 + HO)$.

AMMONIÆ PHOSPHAS. *Phosphate of Ammonia.* $3\,NH_4O,\,PO_5 + 5HO$.

Eight fluid ounces of strong solution of Ammonia are added to twenty fluid ounces of Dilute Phosphoric Acid; the crystalline precipitate which results is dissolved by a gentle heat, and the solution set aside for crystals to form. These are removed and dried quickly on filtering paper.

This salt is formed by direct combination:

$3NH_4O + (3HO,\,PO_5) + xAq. = (3NH_4O,\,PO_5 + 5HO) + xAq.$

ANTIMONII OXIDUM. *Oxide of Antimony. Teroxide of Antimony* $Sb\,O_3$.

Sixteen fluid ounces of Solution of Terchloride of Antimony are poured into two gallons of water and to the precipitate, separated and thoroughly washed, a solution of five ounces of Carbonate of Soda in two pints of distilled water is added. The mixture is set aside for half an hour and well stirred. The deposit is collected, washed, and dried at under 212°.

Solution of Terchloride of Antimony consists of Terchloride of Antimony dissolved in excess of Hydrochloric Acid. When this solution is added to water, part of the latter is decomposed—its Hydrogen forming Hydrochloric Acid with the Chlorine of the Terchloride, and its Oxygen

entering into combination with the Antimony, thus:

$$6\ SbCl_3HCl + 15HO + xAq = 21HCl + SbCl_3\ 5SbO_3 + xAq.$$

When one eq. of the new compound ($SbCl_3\ 5\ SbO_3$) is mixed with three eq. of Carbonate of Soda, the result is, six eq. of Teroxide of Antimony, three eq. of Chloride of Sodium, and three eq. of Carbonic Acid:

$$(SbCl_3\ 5SbO_3) + 3NaOCO_2 = 6SbO_3 + 3NaCl + 3CO_2.$$

ANTIMONIUM SULPHURATUM. *Sulphurated Antimony. Tersulphuret of Antimony, SbS_3, with a small and variable amount of Teroxide of Antimony, SbO_3.*

Ten ounces of prepared Sulphuret of Antimony are boiled for two hours with four pints and a half of Solution of Soda, replacing with water the loss by evaporation. The liquor is strained, and before it cools a slight excess of dilute Sulphuric Acid is added. The precipitate which forms is collected, washed, and dried.

One eq. of Sulphuret of Antimony boiled with three eq. of Soda, gives three eq. of Sulphuret of Sodium and one eq. of Teroxide of Antimony.

$$(Sb\ S_3 + 3NaO = 3NaS, + SbO_3)$$

The Sulphuret of Sodium holds in solution some uncombined Tersulphuret of Antimony, and the

Teroxide of Antimony is held in solution by some of the Solution of Soda. When the Sulphuric Acid is added, a double series of decompositions takes place, viz:

(*a*).

SbS_3, $NaS + SO_3 + HO = NaO$, $SO_3 + SbS_3 + HS$.

(*b*).

SbO_3, $NaO + SO_3 + HO = NaO$, $SO_3 + SbO_3 + HO$.

The Tersulphuret and Teroxide are thus formed simultaneously, and present the compound of the Pharmacopeia, namely, $SbS_3 + xSbO_3$.

ANTIMONIUM TARTARATUM. *Tartarated Antimony. Tartrate of Antimony and Potash.* SbO_3, KO, $C_8H_4O_{10} + 2HO$.

Five ounces of Teroxide of Antimony, and six ounces of Acid Tartrate of Potash in fine powder, are mixed with sufficient Distilled Water to form a paste. This is set aside for twenty-four hours, and then boiled for a quarter of an hour with a pint and three quarters of Distilled Water. The solution is then filtered, and the filtrate crystallized.

When Teroxide of Antimony is boiled with Acid Tartrate of Potash, it displaces the basic atom of water contained in the latter:

$SbO_3 + KO, HO, \bar{T} + x\ Aq. = (SbO_3, KO, \bar{T} + 2HO) + x\ Aq.$

ARGENTI NITRAS. *Nitrate of Silver*, AgO, NO_5.

A fluid ounce and three quarters of Nitric Acid is mixed with five ounces of Distilled Water, and poured upon three ounces of Refined Silver placed in a flask. A gentle heat is applied until the metal is dissolved; the clear liquor is then evaporated and crystallized.

Three eq. of Silver and four eq. of Nitric Acid are here employed; the result is, three eq. of Nitrate of Silver and one eq. of Nitric Oxide:—

$$3Ag + 4NO_5 = 3AgO, NO_5 + NO_2.$$

ARGENTI OXYDUM. *Oxide of Silver.* AgO.

Half an ounce of crystallized Nitrate of Silver is dissolved in four ounces of Distilled Water, and the solution poured into three pints and a half of Lime Water. After well shaking the deposit is collected on a filter, washed, and gently dried.

The Oxide of Silver in the Nitric Acid is here replaced by Oxide of Calcium or Lime. The decomposition is this:—

$$AgO\ NO_5 + CaO = CaO\ NO_5 + AgO.$$

ATROPIA. *Atropia. An Alkaloid* $C_{34}H_{23}NO_6$ *obtained from Belladonna Root.*

Two pounds of Belladonna Root, recently dried and in coarse powder, are macerated in two quarts of Rectified Spirit for twenty-four hours, stirring frequently. The whole is transferred to

a percolator, and three quarts more Rectified Spirit are passed slowly through it. An ounce of Slaked Lime is now added to this Tincture, and well mixed with it. After filtration, dilute Sulphuric Acid is added in slight excess. The liquid is again filtered, three-fourths of the Spirit distilled off, the remainder mixed with ten ounces of Distilled Water, and evaporated at a gentle heat until reduced to one-third of its volume. After cooling this, solution of Carbonate of Potash is added, so as *nearly* to neutralize the acid, taking care, however, not to use an excess. The whole is now set aside for six hours, filtered, and Carbonate of Potash *in excess* added, it is then mixed thoroughly with ten fluid ounces of Chloroform, poured into a funnel furnished with a glass stopcock, and the Chloroform, when it has subsided, is separated from the supernatant water. The Chloroform solution is now poured into a retort connected with a condenser, and distilled by means of a water bath. The residue is dissolved in warm Rectified Spirit; the solution digested with animal charcoal, filtered, evaporated, and crystallized.

Atropia exists as a Malate and Supermalate in the juice of *Atropa Belladonna*. By Rectified Spirit these salts are entirely extracted, together with colouring matter, &c. On the addition of Lime the Salts of Atropia are decomposed, and the Atropia left in solution. When the new lime

compounds have been removed by filtration, Sulphuric Acid is added to the tincture in order to combine with the Atropia, Sulphate of Atropia being less susceptible of decomposing influences than the free alkaloid. The first addition of Carbonate of Potash, *not* in excess, serves to free the Solution of Sulphate of Atropia from a certain resinous substance with which it is associated, and which, if not removed, materially interferes with its crystallization. The precipitate thus formed having been separated, an excess of Carbonate of Potash is added to precipitate the alkaloid. If the process ended here, the product would be an amorphous light brown powder; it is removed from the water by means of Chloroform, and remains, together with traces of foreign matter, in the retort after removing the Chloroform by distillation. Rectified Spirit takes up the Atropia and colouring matter only, and animal charcoal removing the latter, a spirituous solution of pure Atropia is obtained, from which it has only to be crystallized.

Great nicety is required in the addition of the Carbonate of Potash; it must be dropped in, and as soon as the precipitate formed has a floculent appearance, no more should be added until after filtration.

(The Austrian Pharmacopeia gives the following process for the preparation of Atropia:

Make a concentrated watery extract of the root

of *Atropa Belladonna*, and add to this, solution of Iodide of Potassium and Iodine until no further precipitate is produced. Decompose this precipitate with Zinc and water, mix the clear solution with solution of Carbonate of Potash, evaporate gently to dryness, and dissolve the residue in Alcohol and filter. From this solution pure Atropia crystallizes out.)

BEBERIÆ SULPHAS. *Sulphate of Bebeeria. The Sulphate of an Alkaloid,* $C_{38}H_2$, NO_6, HO, SO_3, *prepared from Bebeeru Bark.*

Half a fluid ounce of Sulphuric Acid is diluted with a gallon of water, and of this mixture sufficient is poured upon a pound of coarsely powdered Bebeeru Bark to moisten it thoroughly; after maceration for twenty-four hours this is placed in a percolator, and the remainder of the Acidulated Water passed through it. The acid liquor in the receiver is concentrated to a pint, cooled, and slaked lime added, but not in excess. After two hours the precipitate is removed by filtration, and Solution of Ammonia added to the filtrate until the fluid has a faint ammoniacal odour. The precipitate is collected, washed twice with ten ounces of cold water, and dried on a vapour bath. The dry precipitate is powdered, boiled with six ounces of Rectified Spirit, set aside for a few minutes, and the Spirit decanted. The undissolved portion

is treated with successive quantities of Spirit until exhausted. The spirituous solutions are now mixed, four ounces of Distilled Water added, and subjected to distillation, so as to recover the greater part of the Spirit. To what is left in the retort, dilute Sulphuric Acid is added by degrees and with constant stirring, till the fluid has a slight acid reaction. The whole is now evaporated to complete dryness on a water bath, the dry product pulverized, and a pint of cold Distilled Water gradually poured on it, stirring diligently. This solution is filtered through paper, the filtrate evaporated to the consistence of syrup, and scaled.

Bebeeria exists in the root of *Nectandra Rodiei*, whence it is extracted by Sulphuric Acid. The excess of this is removed by Lime, and the Bebeeria-compounds are decomposed by Ammonia. The precipitate formed by the addition of the latter is washed, dried, and digested in Rectified Spirit, which dissolves it. After recovering most of the Spirit by distillation, the residue is made into a Sulphate by the direct addition of dilute Sulphuric Acid, after which the liquid is evaporated to dryness and the dry residue dissolved in water. Thus a watery solution of Sulphate of Bebeeria is obtained, which is to be evaporated and scaled in the same manner as solution of Ammonio-Citrate of Iron.

Bismuthum Album. *White Bismuth.* BiO_3NO_5.

Two fluid ounces and a half of Nitric Acid are diluted with three ounces of Water, and two ounces of Bismuth, in coarse powder, added in successive portions. Effervescence having ceased, the liquid is nearly boiled for ten minutes; the solution is then decanted, evaporated to two fluid ounces, and poured into half a gallon of water. After some time the precipitate is separated from the supernatant fluid, well washed, and dried at 212°.

One eq. of Bismuth and four eq. of Nitric Acid are here employed: the resulting solution consists of Ternitrate of Bismuth and water; some Nitric Oxide having escaped. To free the solution entirely from oxides of Nitrogen, it is boiled,—and, this done, it is poured into a large quantity of water. The ternitrate of Bismuth becomes now broken up into two distinct compounds—a *Subnitrate* (trisnitrate), insoluble, and represented by the formula BiO_3, NO_5, and a soluble *Supernitrate*, composed of one atom of teroxide of Bismuth, and nine of Nitric Acid. The former is that of the Pharmacopeia.

The decompositions are thus represented:—

(*a*). $Bi + 4NO_5 = BiO_3\ 3NO_5 + NO_2$.

(*b*). $4BiO_3\ 3NO_5 + xAq. = 3BiO_3\ NO_5 + BiO_3,\ 9NO_5 + xAq.$

CALCIS CARBONAS PRÆCIPITATA. *Precipitated Carbonate of Lime*, $Ca.O$, CO_2.

Five ounces of Chloride of Calcium are dissolved in two pints of boiling Distilled Water, and thirteen ounces of Carbonate of Soda in another two pints of boiling Distilled Water. These solutions are mixed, the precipitate collected, washed with boiling Distilled Water until the washings no longer give a precipitate with Nitrate of Silver, and dried at 212°.

One eq. of Chloride of Calcium, and one eq. of Carbonate of Soda here exchange bases—Carbonate of Lime and Chloride of Sodium resulting:—

$$CaCl + NaO,\ CO_2 + xAq. = CaO,\ CO_2 + NaCl + xAq.$$

CALCIS HYDRAS. *Slaked Lime* CaO, HO.

Two pounds of Lime, recently burned, are mixed with a pint of Distilled Water in a metal pot, which is to be covered when vapours cease to be disengaged.

Lime and water combine in definite proportions —one eq., or twenty-nine parts by weight of Lime requiring one eq., or nine parts by weight of water. More water than enters into combination with the Lime is ordered by the Pharmacopeia, as the great heat produced converts much of it into vapour. Hydrate of Lime greedily attracts Carbonic Acid from the atmosphere and becomes a Carbonate, hence it is

ordered to be recently prepared. It is possible to obtain it in the crystalline form.

CALCIS PHOSPHAS PRÆCIPITATA. *Precipitated Phosphate of Lime.* 3 CaO, PO_5.

Four ounces of Bone Ash are digested in six fluid ounces of Hydrochloric Acid, diluted with a pint of Distilled Water, until dissolved; the solution is filtered, another pint of Distilled Water added, and then sufficient Solution of Ammonia to give the mixture an alkaline reaction. The precipitate is now collected, washed with boiling Distilled Water as long as the washings give a precipitate with solution of Nitrate of Silver acidulated with Nitric Acid, then dried at under 212°.

Bone Ash consists of Basic Phosphate of Lime with about ten per cent of Carbonate of Lime: the Phosphate is dissolved and the Carbonate decomposed by the Hydrochloric Acid. There are, therefore, in solution, Basic Phosphate of Lime, Hydrochloric Acid, and Chloride of Calcium, Carbonic Acid having escaped. On the addition of Ammonia to these, the Phosphate of Lime is precipitated, together with some Lime,—resulting from the decomposition of Chloride of Calcium—and Chloride of Ammonium remains in solution. The decomposition is this:

(*a*). $3\ CaO.\ PO_5 + HCl + NH_4O = NH_4Cl + 3\ CaO\ PO_5 + HO.$

(*b*). $CaCl + NH_4O = CaO + NH_4\ Cl.$

As the Phosphate of Lime is insoluble in water, the Lime and Chloride of Ammonium are easily removed by washing.

CALOMELAS. *Calomel. Subchloride of Mercury.* $Hg_2Cl.$

Ten ounces of Sulphate of Mercury are moistened with water, and rubbed with seven ounces by weight of Mercury; five ounces of dried Chloride of Sodium are then added, and the whole is thoroughly mixed by continued trituration. The mixture is sublimed by a suitable apparatus into a chamber of such size that the Calomel shall be produced as a fine powder. This is washed with boiling Distilled Water, until the washings cease to be darkened by Hydrosulphuret of Ammonia, and dried at a heat not exceeding 212°.

When one eq. of Sulphate of Mercury (HgO, SO_3) and one eq. of Chloride of Sodium ($NaCl$) are mixed together and sublimed, an exchange of elements takes place—Chloride of Mercury and Sulphate of Soda being formed. If, however, the *Sub*-chloride of Mercury be required, an eq. of Mercury must be added to the mixture about to be sublimed. The reaction in this case is thus represented:

$HgO, SO_3 + Na\ Cl + Hg + Hg_2Cl + NaOSO_3.$

It depends upon the size and temperature of the receiver whether the product obtained shall be crystalline or an impalpable powder. If the receiver be small and the temperature moderately high, prismatic crystals are obtained; if, on the other hand, it be large and kept cool, the calomel falls as a fine powder.

CARBO ANIMALIS PURIFICATUS. *Purified Animal Charcoal. Bone Black deprived of its earthy salts.*

Ten fluid ounces of Hydrochloric Acid are mixed with a pint of Distilled Water, and sixteen ounces of Bone Black added. These are digested together at a moderate heat for two days, with occasional stirring; the undissolved portion is then collected on a calico filter, and washed with Distilled Water until the washings give scarcely any precipitate with Nitrate of Silver. The charcoal is lastly dried, and heated to redness in a covered crucible.

Bone Black, or "the residue of Ox and Sheep bones, which have been exposed to a red heat without the access of air, reduced to powder," consists of Phosphate and Carbonate of Lime, Carburet and Sulphuret of Iron, Sulphuret of Calcium, and from fifteen to twenty per cent of Charcoal. By digestion in Hydrochloric Acid the Phosphate of Lime is dissolved; the Car-

bonate is broken up into Carbonic Acid and Lime, the first of which escapes, while the other, combining with some Chlorine, forms Chloride of Calcium; and the Sulphuret of Calcium, mixed with Hydrochloric Acid, results in Chloride of Calcium and Sulphuretted Hydrogen. The Iron compounds are also decomposed, soluble Chloride of Iron being formed. These new products are removed by washing.

CHLOROFORMUM. *Chloroform* C_2HCl_3.

Into a capacious still connected with a condensing worm and receiver, three gallons of Water and thirty fluid ounces of Rectified Spirit are put, and the mixture raised to the temperature of 100°. With this, ten pounds of Chlorinated Lime and five pounds of Slaked Lime are thoroughly mixed. Heat is now applied, but the fire is withdrawn as soon as the process is well established. When fifty ounces have passed over they are put into a gallon bottle half filled with water, well mixed, and then set aside for a few minutes. The lower stratum,—crude Chloroform —is washed by shaking it in a bottle with three ounces of Distilled Water; which operation is afterwards repeated with another, and then a third three ounces of Distilled Water. The washed Chloroform is now shaken for five minutes in a bottle with an equal volume of Sulphuric Acid, the mixture allowed to settle, and the

upper stratum transferred to a flask containing two ounces of Chloride of Calcium mixed with half an ounce of dry Slaked Lime. All these are mixed well together, and after the lapse of an hour the flask is connected with a Liebig's condenser, and the pure Chloroform distilled over by means of a water-bath.

When dry Chlorine and anhydrous Alcohol act upon each other, a peculiar oily liquid called *Chloral* ($C_4\ Cl_3\ HO_2$) is the result; and when this liquid is distilled with Hydrate of Lime, or an alkaline Hydrate together with water, Chloroform is produced. In the foregoing process, which is a modification of that given in the last Dublin Pharmacopeia, Chloral is formed by subjecting a mixture of two eq. of Alcohol, and eight eq. of Hypochlorite of Lime (in the presence of Chloride of Calcium, Hydrate of Lime, and Water) to distillation. Both are decomposed, and form Chloral, Lime, Water, Chloride of Calcium, and Formiate of Lime. The Chloral and the Hydrate of Lime then re-act upon each other, producing Chloroform and Formiate of Lime. These changes are thus represented:

(*a*). *Formation of Chloral by the action of Chlorine upon Alcohol:*

$$2\ C_4H_6O_2 + 8\ CaOClO = C_4HCl_3O_2 + CaO + 9\ HO + 5\ CaCl + 2\ (CaO,\ C_2HO_3)$$

D

(*b*). *Formation of Chloroform by the action of Lime upon Chloral:*

$C_4HCl_3\ O_2 + CaO + HO = C_2HCl_3 + CaO,\ C_2HO_3.$

According to the above theory, therefore, the *necessary* ingredients are Alcohol, Hypochlorite of Lime, and Hydrate of Lime—the office of the latter is to render stable some of the newly formed compounds. The Chloride of Calcium plays no part whatever in the process. The Hydrate of Lime in the still serves to fix any Carbonic Acid that may be set free by the action of Hypochlorite of Lime upon Formiate of Lime —which takes place if the Hypochlorite be present in excess.

When the distillation has fairly begun the heat should be withdrawn, or the action will become very violent. The crude Chloroform consists of Chloroform contaminated with certain oily products, part of which are removed by washing with water, and part are decomposed by the Sulphuric Acid. Any water or Sulphuric Acid with which it may now be associated, is removed by Chloride of Calcium and Lime; and the Chloroform is lastly rectified by distillation.

CUPRI SULPHAS. *Sulphate of Copper*, $CuO, SO_3 + 5\ HO.$

Commercial Sulphate of Copper is dissolved in water, and the solution filtered and crystallized.

Blue Vitriol of commerce generally contains as accidental impurities, the Sulphates of Iron and Zinc, and often those of Manganese and Cobalt. By the Pharmacopeia process these are partly, but not entirely, removed.

DIGITALINUM. *Digitalin. The active principle obtained from Digitalis (the dried leaf of Digitalis purpurea; from wild indigenous plants, gathered when about two-thirds of the flowers are expanded).*

Two gallons of Rectified Spirit are poured upon forty ounces of Digitalis in powder, and digested at a heat of 120° for six hours; the Tincture is then separated by filtration and expression. The Spirit having been recovered by distillation, the residual extract is treated with five ounces of water acidulated with half a fluid ounce of Acetic Acid, then digested with a quarter of an ounce of Animal Charcoal, filtered, and the filtrate diluted with water to the bulk of a pint. Solution of Ammonia is now added nearly to neutralization, and then a solution of a hundred and sixty grains of Tannic Acid in three ounces of water. The precipitate thus obtained is washed with a little water, then mixed with a small quantity of Rectified Spirit, and carefully rubbed in a mortar with a quarter of an ounce of finely powdered Litharge. The mixture is placed in a flask, and four ounces of Rectified Spirit added; it is then maintained

at a temperature of 160° for about an hour. After digesting with another quarter of an ounce of Animal Charcoal, it is filtered, the spirit removed by distillation, and the product washed repeatedly with Ether.

The Tincture of Digitalis of this process contains Digitalin, extractive, coloring matter, &c. On the addition of Acetic Acid and Animal Charcoal the Digitalin is dissolved by the Acid, and the solution partially decolorized by the Charcoal. Ammonia is now added to decompose the Acetic solution of Digitalin; thus Acetate of Ammonia is formed, and Digitalin set free. On the addition of Tannic Acid to the solution of free Digitalin, an insoluble compound of Digitalin is formed and deposited, and this, after washing with water and spirit, is decomposed by Oxide of Lead—insoluble Tannate of Lead resulting, and Digitalin being again set free. By heating the mixture for some time with spirit, a Tincture of Digitalin is formed, which is still coloured and contains traces of extractive. More Animal Charcoal is employed to further decolorize, and this, together with the Tannate of Lead, is removed by filtration. The Rectified Spirit is now recovered from the filtrate by distillation, and the residue, consisting of Digitalin, with a little extractive and certain other impurities, is treated with Ether. This removes all but the Digitalin which remains as a whitish pulverulent mass.

EMPLASTRUM LITHARGYRI. *Litharge Plaster.*

Four pounds of Litharge in very fine powder, one gallon of Olive Oil, and three pints and a half of water are gently boiled together in a copper pan over a clear fire, and kept simmering for four or five hours, until the Oil and Litharge acquire a proper consistence for a plaster.

Olive Oil consists of the Oleate and Margarate of Glycerine. When these are boiled for some time with Oxide of Lead, their base, Glycerine, is replaced by the oxide, and Oleate and Margarate of Lead are formed—the Glycerine being set free, and remaining in the water.

FERRI ARSENIAS. *Arseniate of Iron. Arseniate of Iron,* $3FeO, AsO_5$, *partially oxidated.*

Three ounces of Acetate of Soda, and four ounces of Arseniate of Soda, dried at 300°, are dissolved in two pints of boiling Distilled Water, and nine ounces of Sulphate of Iron are dissolved in three pints of boiling Distilled Water. The solutions are mixed, and the white precipitate collected on a calico filter, and washed until the washings cease to be affected by a dilute solution of Chloride of Barium. The washed precipitate is squeezed between folds of linen in a press, and dried in a hot air chamber at a temperature under 100°.

The officinal Arseniate of Soda consists of two atoms of Soda and one of water as base; that the result of its decomposition with Sulphate of Iron may be a basic Arseniate of Iron, another salt of Soda must be laid under contribution for an atom of Soda, to take the place of the basic atom of water. The Acetate of Soda is chosen for this purpose, and when this and the Arseniate of Soda, both in solution, are added to a solution of Sulphate of Iron, the reaction is this :

$(2NaO, HO, AsO_5) + NaO, \bar{A} + 3FeO, SO_3 + xAq.$
$= (3FeO, AsO_5) + 3NaO, SO_3 + \bar{A} + HO + xAq.$

FERRI CARBONAS SACCHARATA. *Saccharated Carbonate of Iron. Carbonate of Iron, FeO, CO_2, mixed with Peroxide of Iron and Sugar, and forming at least fifty-seven per cent of the mixture.*

Two ounces of Sulphate of Iron and two ounces and a half of Carbonate of Soda are dissolved each in half a gallon of boiling Distilled Water; the solutions are then mixed and briskly stirred in a deep cylindrical vessel. The mixture is set aside in this vessel, which must be covered as accurately as possible, for twenty-four hours, and the clear liquid separated from the precipitate by a siphon. The precipitate is well washed with a gallon of Distilled Water, then collected on a calico filter, pressed, rubbed in a porcelain mortar

with an ounce of Refined Sugar, and dried at a temperature not exceeding 212°.

One eq. of Sulphate of Iron and one eq. of Carbonate of Soda here exchange elements.

$$FeOSO_3 + NaOCO_2 + xAq. = FeO,\ CO_2 + NaO,\ SO_3 + xAq.$$

Part of the resulting Carbonate of Iron, from attracting Oxygen, is changed into Peroxide. The Pharmacopeia requires that the compound shall contain at least fifty-seven per cent of Carbonate, and gives a test for its quantitative determination.

FERRI ET AMMONIÆ CITRAS. *Citrate of Iron and Ammonia.*

$(Fe_2O_3,\ NH_4O,\ HO,\ C_{12}H_5O_{11} + 2HO)$?

Eight fluid ounces of Solution of Persulphate of Iron are added to two pints of Distilled Water, and this dilute solution gradually poured into Solution of Ammonia, sufficient in quantity to precipitate all the Peroxide of Iron from the Solution of Persulphate. This precipitate is collected on a filter, and washed with Distilled Water until the filtrate ceases to become turbid on the addition of Chloride of Barium. It is then boiled in a solution of five ounces of Citric Acid in a quart of Distilled Water, and when dissolved, the solution is neutralized by solution of Ammonia. The mixture is lastly evaporated to dryness on plates.

One eq. of Persulphate of Iron requires three eq. of Ammonia to replace its Peroxide,

$Fe_2O_3, 3SO_3 + 3NH_4O = Fe_2O_3 + 3NH_4O, SO_3.$

According to the Pharmacopeia, this eq. of Peroxide of Iron, when boiled with one eq. of Citric Acid ($3HO, \overline{Ci}$) replaces a basic atom of water,

$Fe_2O_3 + 3HO, \overline{Ci} + xAq = Fe_2O_3, 2HO, \overline{Ci} + xAq.$

On now adding an eq. of Ammonia to replace a second basic atom of water, a salt is formed corresponding to the formula given in the Pharmacopeia.

$Fe_2O_3, 2HO, \overline{Ci} + NH_4O = (Fe_2O_3, NH_4O, HO, \overline{Ci}).$

FERRI ET QUINIÆ CITRAS. *Citrate of Iron and Quinia. Citric Acid combined with Peroxide of Iron, Protoxide of Iron, and Quinia.*

Three fluid ounces of Solution of Persulphate of Iron are well mixed with a solution of one ounce of Protosulphate of Iron in ten ounces of Distilled Water, and the mixture is poured into thirty-six fluid ounces of Solution of Soda. The precipitate is collected on a calico filter, and washed with Distilled Water until the washings cease to give a precipitate with Chloride of Barium. It is then added to a solution of two ounces and a quarter of crystallized Citric Acid in twenty fluid ounces of Distilled Water, and the mixture is digested on a water bath, with repeated stirring, until the precipitate is dissolved.

A solution is now made of three hundred and eighty grains of Sulphate of Quinia in eight ounces of Distilled Water acidulated with a little dilute Hydrochloric Acid, and to this sufficient solution of Chloride of Barium to precipitate the Sulphuric Acid is added. The Sulphate of Baryta is now separated by filtration, and to the filtrate a slight excess of Ammonia is added. The precipitate is well washed with Distilled Water, and added to the solution of Citrate of Iron; all are then digested together on a water bath until a perfect solution is obtained. This solution is to be evaporated on plates at a temperature below 212°.

By decomposing solutions of Persulphate and Protosulphate of Iron with Soda, in the above proportions, a mixed precipitate consisting of three eq. of Peroxide of Iron, and three eq. of Protoxide of Iron is obtained. Five eq. of Citric Acid are employed to dissolve this; hence, taking the formula of Citrate of Protoxide of Iron as $3FeO, \bar{Ci}$, that of Citrate of Peroxide of Iron as $Fe_2O_3, 2HO, \bar{Ci}$, the solution in the capsule will contain one eq. of basic Citrate of Protoxide of Iron, three eq. of Citrate of Peroxide of Iron, as written above, and one eq. of free Citric Acid, together with some water. This free Citric Acid, on the addition of one eq. of Quinia, combines with it, forming a Citrate of Quinia consisting of one atom of Quinia and two basic atoms of water to each atom of Acid. This would give the *Ferri*

et Quiniæ Citras of the Pharmacopeia the following composition:
$(3FeO, \bar{C}i) + 3\ (Fe_2O_3, 2HO, \bar{C}i) + (C_{20}H_{12}NO_2, 2HO, \bar{C}i)$?

FERRI IODIDUM. *Iodide of Iron. Fe I.*

An ounce and a half of fine Iron Wire, three ounces of Iodine, and twelve ounces of Distilled Water are gently heated together in a flask for about ten minutes, the heat is then raised, and the solution boiled until it loses its red colour. It is now filtered through paper, the paper washed with three ounces of Distilled Water, and the solution and washings boiled down together until sufficiently concentrated to solidify when cold. It is lastly poured on a porcelain dish, that it may become solid.

One eq. of Iodine here directly combines with one eq. of Iron. A great excess of the latter is employed, in order to guard against any material waste of Iodine by the heat to which the mixture is subjected.

FERRI OXIDUM MAGNETICUM. *Magnetic Oxide of Iron. Peroxide of Iron, Fe_2O_3, with about nine per cent of Protoxide of Iron, FeO, and twenty-two per cent of Water.*

Three fluid drachms of Sulphuric Acid are diluted with five ounces of Distilled water, and four ounces of Sulphate of Iron are dissolved, by the aid of heat, in the mixture. Two fluid

drachms of Nitric Acid are now mixed with two ounces of Distilled Water, added to the solution of Sulphate of Iron, and boiled. When the liquid has passed from a dark to a red colour, two more ounces of Sulphate of Iron, first dissolved in half a pint of Distilled Water, are added; and when these are well mixed, fifty-eight fluid ounces (or as much as may suffice to precipitate all the oxides of Iron) of Solution of Soda are also added. The precipitate which results (after boiling for five minutes in an iron vessel) is collected on a calico filter, thoroughly washed with boiling Distilled Water, and dried without heat over Sulphuric Acid.

In the first part of this process Protosulphate of Iron is converted into Persulphate. Six eq. of Protosulphate abstract three atoms of Oxygen from an eq. of Nitric Acid:—

$$6FeOSO_3 + NO_5 = 3Fe_2O_3 + 6SO_3 + NO_2.$$

But three eq. of Sulphuric Acid have been previously added, and these, with the six in the above equation form, together with the three eq. of Peroxide of Iron, three eq. of Persulphate of Iron:

$$3Fe_2O_3 + 6SO_3 + 3SO_3 = 3\ (Fe_2O_3, 3SO_3)$$

To this solution of Persulphate of Iron, half as much Protosulphate as was first employed is added, dissolved in a considerable quantity of water. Soda precipitates from this mixture the two oxides, forming with their Sulphuric Acid Sulphate of Soda:

$$(FeO,\ SO_3) + (Fe_2O_3,\ 3SO_3) + 4NaO + xAq = (FeO + Fe_2O_3 + HO) + 4NaOSO_3.$$

This formula does not exactly represent the composition of the Magnetic Oxide of Iron of the Pharmacopeia, which should contain less Protoxide and be associated with more water. It is probable however that part of the Protoxide in the above process is converted by absorption of Oxygen into Peroxide.

FERRI PEROXIDUM. *Peroxide of Iron* Fe_2O_3, HO.

Hydrated Peroxide of Iron is first dried in a stove or oven, then exposed to a heat of 212° until it ceases to lose weight.

Hydrated Peroxide of Iron consists of two at. of Peroxide of Iron, three at. of water—and a variable quantity of uncombined water. By drying, the latter is got rid of, and by afterwards heating at 212° the three at. of combined water are reduced to two.

FERRI PEROXIDUM HYDRATUM. *Hydrated Peroxide of Iron,* $2Fe_2O_3$, $3HO$, *with a variable amount of uncombined water.*

Four fluid ounces of Solution of Persulphate of Iron are mixed with a pint of Distilled Water, and poured into sufficient Solution of Soda to decompose the whole of it. After well stirring, this precipitate is collected on a calico filter and

thoroughly washed. It is lastly transferred, without drying, to a porcelain pot, made as air-tight as possible.

Two eq. of Persulphate of Iron are here decomposed by six eq. of Soda; Hydrated Peroxide of Iron is precipitated, and Sulphate of Soda remains in solution. The product is a sesquihydrate, and contains about fifteen per cent of combined water. The decomposition is thus written:

$$2\,(Fe_2O_3\,3SO_3) + 6NaO + xAq = (2Fe_2O_3,\,3HO) + 6NaO,SO_3 + xAq.$$

FERRI PHOSPHAS. *Phosphate of Iron. Phosphate of Iron,* $3FeO,PO_5$, *partially oxidated.*

Three ounces of Sulphate of Iron are dissolved in a quart of boiling Distilled Water; and two ounces and a half of Phosphate of Soda, with an ounce of Acetate of Soda, in another quart of boiling Distilled Water. The solutions are well mixed, and the precipitate transferred to a calico filter, and thoroughly washed with hot Distilled Water. It is lastly dried at a heat not exceeding 100°.

Phosphate of Soda contains as base to each atom of Phosphoric Acid, two at. of Soda and one at. of water. Another at. of Soda is therefore necessary to produce with the Sulphate of Iron the required result. This at. is supplied by Acetate of Soda. On mixing the solutions basic

Phosphate of Iron is precipitated, and Sulphate of Soda, with some free Acetic Acid, left in solution.

$$(2NaO, HO, PO_5) + NaO, \bar{A} + 3FeO, SO_3 = (3FeO, PO_5) + 3NaO, SO_3 + \bar{A}.$$

FERRI SULPHAS. *Sulphate of Iron*, $FeO, SO_3 + 7HO$.

Iron Wire is dissolved in dilute Sulphuric Acid, and the solution boiled when the disengagement of gas has nearly ceased. It is then filtered and crystallized.

Monohydrated Sulphuric Acid has no immediate action upon Iron. But when considerably more water is present, decomposition quickly takes place, the Iron is oxidized, and Hydrogen is evolved. With the Protoxide of Iron the Sulphuric Acid combines:—

$$Fe + HO, SO_3 + xAq. = FeO, SO_3 + 7HO + H + xAq.$$

The *Ferri Sulphas Granulata* of the Pharmacopeia is obtained by filtering the solution formed by the above process into Rectified Spirit. It has the same composition as the crystallized.

The *Ferri Sulphas Exsiccata* is prepared by exposing Sulphate of Iron to a heat approaching 400°, as long as aqueous vapours are evolved. It is thus deprived of most of its water of crystallization; its loss in weight is nearly forty per cent.

FERRUM REDACTUM. *Reduced Iron, Metallic Iron, with a variable amount of Magnetic Oxide of Iron.*

Peroxide of Iron is placed in the middle of a gunbarrel, and kept in position by plugs of Asbestos. The barrel is made thoroughly red hot in a furnace, and while thus, it is traversed by a stream of Hydrogen Gas (evolved by the action of dilute Sulphuric Acid upon Zinc, and rendered quite dry by being made to pass through Sulphuric Acid, and over Chloride of Calcium). The process is completed when Hydrogen is no longer absorbed.

Three atoms of Hydrogen here combine with the Oxygen of one eq. of Peroxide of Iron; thus forming three eq. of water, most of which escapes as steam, and leaving Iron in a finely divided state in the gunbarrel:—

$$Fe_2O_3 + 3\ H = 2\ Fe + 3\ HO.$$

Part of this Iron, being red hot, is unavoidably converted into Magnetic Oxide by contact with the steam—hence the Pharmacopeia recognizes its presence, and gives a test for its estimation.

FERRUM TARTARATUM. *Tartarated Iron. Tartrate of Iron and Potash,* Fe_2O_3, KO, $C_8H_4O_{10} + HO$..

Four fluid ounces of solution of Persulphate of Iron are added to a pint of Distilled Water, and

the dilute solution gradually poured into two pints of Solution of Soda, (or as much as may suffice to precipitate the whole of the oxide). After well mixing, the precipitate is collected, and thoroughly washed. It is then added to a mixture of two ounces of Acid Tartrate of Potash and thirty ounces of Distilled Water, and the whole is digested for six hours, with repeated stirring, at a temperature under 140°. After it has cooled, the clear portion is decanted, spread upon plates, and evaporated to dryness at a temperature not exceeding 140°.

Tartaric Acid is bibasic—Acid Tartrate of Potash is therefore expressed by the formula KO, HO, $\overline{T}$. In the above process Hydrated Peroxide of Iron is formed by decomposing Solution of Persulphate of Iron with Soda, and added to the Acid Tartrate of Potash to replace its basic atom of water:

$$(2Fe_2O_3\ 3HO) + 2KO,\ HO,\ \overline{T} = 2\ (Fe_2O_3,\ KO,\ \overline{T} + HO) + 6HO.$$

HYDRARGYRI IODIDUM RUBRUM. *Red Iodide of Mercury. Hg I.*

Four ounces of Corrosive Sublimate are dissolved in three pints of boiling Distilled Water, and five ounces of Iodide of Potassium in another two pints of boiling Distilled Water. The solutions are mixed, and when cold the precipitate is

collected, washed with cold Distilled Water, and dried at a temperature not exceeding 212°.

In this process there is merely an exchange of elements between Corrosive Sublimate (Chloride of Mercury) and Iodide of Potassium, Iodide of Mercury and Chloride of Potassium resulting

$$HgCl + KI = KCl + HgI.$$

HYDRARGYRI IODIDUM VIRIDE. *Green Iodide of Mercury*, $Hg_2 I$.

An ounce of Mercury, and two hundred and seventy-eight grains of Iodine are rubbed together until metallic globules are no longer visible, and the whole assumes a green colour.

Two eq. of Mercury here directly combine with one eq. of Iodine.

$$2Hg + I = Hg_2 I.$$

HYDRARGYRI OXIDUM RUBRUM. *Red Oxide of Mercury.*

Four ounces of Mercury are dissolved in three fluid ounces of Nitric Acid diluted with two ounces of water. The solution is evaporated to dryness, and four more ounces of Mercury rubbed with the dry salt until the two are uniformly blended. The mixture is now heated in a porcelain capsule, with repeated stirring, until acid vapours cease to be evolved.

In the first part of this process three eq. of Mercury and four eq. of Nitric Acid combine,

forming three eq. of Pernitrate of Mercury, and one eq. of Nitric Oxide:—

$$3Hg + 4NO_5 = 3HgO,\ NO_5 + NO_2.$$

Heated, this salt gives up part of its acid, and a Subnitrate of Mercury is formed:—

$$2HgO,\ NO_5 = (2HgO,\ NO_5) + NO_5$$

Mercury being now added to the dry salt, Peroxide of Mercury and Nitrous Acid are formed:—

$$(2HgO,\ NO_5) + 2Hg = 4HgO + NO_2.$$

HYDRARGYRUM. *Mercury*, Hg.

Commercial Mercury is distilled, and the distillate boiled for five minutes with dilute Hydrochloric Acid.

The ordinary impurities of Mercury are Zinc, Tin, Lead, Antimony, and Bismuth. These, with the exception of traces carried over mechanically, are left behind on distillation. To remove such traces, dilute Hydrochloric Acid is employed, which dissolves them, and forms compounds removeable by washing. Some chemists recommend a layer of sand to be placed over the Mercury in the retort, in order to separate the impurities from the vapour about to pass over.

HYDRARGYRUM AMMONIATUM. *Ammoniated Mercury*, NH_2Hg_2Cl.

Three ounces of Corrosive Sublimate are dissolved in three pints of Distilled Water with the

aid of a moderate heat, and well mixed with four ounces of Solution of Ammonia. The precipitate is collected on a filter, and washed with cold Distilled Water until the washings cease to give a precipitate with solution of Nitrate of Silver acidulated with Nitric Acid; it is lastly dried at a temperature not exceeding 212°.

Two eq. of Corrosive Sublimate (*HgCl*) and two eq. of Ammonia are here employed. The Chloride of Mercury gives up half its Chlorine, which combines with an eq. of Ammonium, resulting from the breaking up of two eq. of Ammonia into Ammonium, Amidogen and water ($2NH_4O = NH_4 + NH_2 + 2HO$). The result is therefore: one eq. of Subchloride of Mercury, Hg_2Cl, with one eq. of Amidogen NH_2, forming the precipitate; and Chloride of Ammonium, remaining in solution:

$$2HgCl + 2NH_4O = NH_2HgCl + NH_4Cl + 2HO.$$

This same compound is called also *Amidochloride of Mercury*, and thus written: *Hg, NH_2, HgCl.*

HYDRARGYRUM CORROSIVUM SUBLIMATUM. *Corrosive Sublimate. Chloride of Mercury, HgCl.*

Twenty ounces of Sulphate of Mercury, ten ounces of dried Chloride of Sodium, and an ounce of black Oxide of Manganese, each reduced to a fine powder, are intimately mixed together. This mixture is placed in a tall green glass matrass,

and sufficient heat applied through a sand bath to sublime the Chloride of Mercury that is formed.

One eq. of Sulphate of Mercury and one eq. of Chloride of Sodium here decompose each other, Sulphate of Soda and Chloride of Mercury resulting:—

$$HgO,\ SO_3 + NaCl = NaO,\ SO_3 + HgCl.$$

If the Sulphate of Mercury be free from Sulphate of the Suboxide, which it seldom is, the Oxide of Manganese plays no part in the process. But if this impurity should be present, the Oxide of Manganese supplies the Oxygen required for converting it into the higher Sulphate, that of the Peroxide. But for it, the Sublimate would be contaminated with Calomel, or Subchloride of Mercury.

IODUM. *Iodine. I.*

Commercial Iodine, placed in a circular porcelain capsule, which is accurately covered with a glass matrass filled with cold water, is exposed to the heat of boiling water for twenty minutes. The matrass being now removed, any "colourless acicular prisms of a pungent odour" that may be found adhering to it are detached, the matrass replaced, and a gentle heat applied to the capsule, that the whole of the Iodine may sublime. The purified product is found attached to the bottom of the matrass.

The crystals *first* sublimed in the above process consist of Cyanide of Iodine, resulting from the decomposition of marine organisms, and the only *accidental* impurity of commercial Iodine. The adulterations of Iodine are *said to be* Coal, Plumbago, Binoxide of Manganese, Sand and Charcoal: from these, if present, Iodine will be separated by sublimation.

LIQUOR AMMONIÆ ACETATIS. *Solution of Acetate of Ammonia. Acetate of Ammonia,* NH_4O, $C_4H_3O_3$, *dissolved in water.*

Strong Solution of Ammonia is neutralized with Acetic Acid. The product contains about thirty-two per cent of Acetate of Ammonia, NH_4O, $C_4H_3O_3$.

LIQUOR AMMONIÆ FORTIOR. "*Strong Solution of Ammonia.*" *Ammoniacal Gas,* NH_3, *dissolved in water, and constituting* 32·5 *per cent of the solution.*

Three pounds of coarsely powdered Hydrochlorate of Ammonia and four pounds of slaked Lime are mixed, and introduced into an iron bottle placed in a sand bath. This bottle is connected with a pint Woulf's bottle—this with a second Woulf's bottle of the same capacity—this second with a three-pint matrass containing twenty-two ounces of Distilled Water—and the

matrass, by means of a tube bent twice at right angles, with an ordinary bottle containing ten ounces of Distilled Water. The second Woulf's bottle and the matrass having been furnished with safety tubes charged with mercury, heat is applied to the mixture and continued as long as bubbles of Ammonia escape from the tube which dips into the water of the matrass, the contents of which, when the process has terminated, will consist of Strong Solution of Ammonia, and measure about forty-three ounces.

The ammoniacal liquor contained in the Woulf's bottles, is heated in a flask and the gas evolved conveyed into the terminal bottle of the above process. When only three-fourths remain in the flask, the liquid in the bottle will be nearly of the strength of Solution of Ammonia, and may be made exactly so by the addition of Distilled Water, or of Strong Solution of Ammonia.

One eq. of Lime here decomposes one eq. of Hydrochlorate of Ammonia: but more Lime than this is used in order to facilitate the process by bringing every particle of Hydrochlorate into contact with it. Ammonia, Chloride of Calcium, and water are the result of the decomposition:

$$NH_4Cl + CaO, HO = CaCl + NH_3 + 2HO.$$

On heat being applied the Lime first loses its water of hydration, which, together with some free Ammonia and impurities, passes into the

Woulf's bottles, where it serves to wash the ammoniacal gas proceeding to the matrass.

LIQUOR ANTIMONII TERCHLORIDI. *Solution of Terchloride of Antimony. Terchloride of Antimony, $SbCl_3$, dissolved in Hydrochloric Acid.*

To a pound of prepared (*i.e.* finely powdered) Sulphuret of Antimony, placed in a porcelain basin, four pints of commercial Hydrochloric Acid are added. The mixture is placed beneath a flue with a good draught, and gently heated; gradually increasing the heat until the liquid boils. After boiling for fifteen minutes the solution is made thoroughly bright by filtration through calico, and boiled down to the bulk of two pints.

One eq. of Tersulphuret of Antimony and three eq. of Hydrochloric Acid here decompose each other. The result is, the evolution of a large quantity of Sulphuretted Hydrogen (on account of which the "flue with a good draught" is indispensable), and of Hydrochloric Acid vapour; and at the same time, the replacement by Chlorine of the Sulphuret of Antimony's Sulphur. The excess of Hydrochloric Acid being large, the newly formed compound, Terchloride of Antimony, is dissolved in it, and thus presented in the form of solution. The process is to be thus written:—

$$Sb S_3 + 3HCl = xHCl = (SbCl_3 + HCl) + 3HS + xHCl. \text{ (vapour)}$$

LIQUOR ARSENICALIS. *Arsenical Solution.*

Eighty grains of Arsenious Acid, and eighty grains of Carbonate of Potash are mixed in a flask with ten ounces of water, and heat applied until a clear solution is obtained. This is made up to a pint with Distilled Water, after having been coloured with Compound Tincture of Lavender.

One eq. of Arsenious Acid here combines with one eq. of Potash, forming Arsenite of Potash, and setting Carbonic Acid free:

$$As, O_3 + KO, CO_2 - KO, AsO_3 + CO_2.$$

The solution is slightly alkaline, on account of the trifling excess of Carbonate of Potash employed.

LIQUOR CHLORI. *Solution of Chlorine. Chlorine gas dissolved in half its volume of water, and constituting* 0·006 *of the weight of the solution.*

Upon one ounce of black Oxide of Manganese in a flask six fluid ounces of Hydrochloric Acid, first diluted with two ounces of Distilled Water, are poured. The Chlorine evolved is washed by passing through water in an intermediate bottle, and is conveyed thence to the bottom of a three-pint bottle containing thirty ounces of Distilled Water, and the mouth of which is loosely plugged with tow. This bottle, when the developement of gas has ceased, is to be corked loosely, and shaken until the Chlorine is absorbed.

One eq. of Peroxide of Manganese requires two eq. of Hydrochloric Acid for the evolution of Chlorine: in this process a somewhat larger quantity of Acid than necessary is employed. The decomposition is this:

$$MnO_2 + 2HCl = Cl + 2HO + MnCl.$$

The flask, or "gas bottle" should be large enough to hold at least three times the quantity of ingredients used. The tubes in the intermediate bottle must be so arranged as to wash the Chlorine before it proceeds to the receiver; and the cooler the water in this (the receiver) is kept the better, since in cold water Chlorine is more freely soluble than in warm.

LIQUOR FERRI PERCHLORIDI. *Solution of Perchloride of Iron. Perchloride of Iron,* Fe_2Cl_3 *in solution in water.*

Ten fluid ounces of Hydrochloric Acid are diluted with five ounces of Distilled Water, and the mixture poured in successive portions upon two ounces of Iron Wire, applying a gentle heat when the action becomes feeble, so that the whole of the metal may be dissolved. Six fluid drachms of Nitric Acid are now diluted with two ounces of Distilled Water, and the dilute acid poured into the solution of Iron. The whole is now evaporated until the bulk is reduced to ten fluid ounces.

Six eq. of Iron, nine eq. of Hydrochloric Acid, and one eq. of Nitric Acid are here employed. In the first part of the process the Iron decomposes the Hydrochloric Acid, Chloride of Iron being formed, and Hydrogen evolved.

$$6Fe + 9HCl = 6FeCl + 6H + 3HCl.$$

The solution contains therefore Protochloride of Iron, with somewhat more than three eq. of free Hydrochloric Acid. The latter gives up three atoms of Oxygen, which, combining with the Hydrogen of the three eq. of Hydrochloric Acid, form water, and leave three eq. of Chlorine. These convert the Protochloride of Iron into Perchloride. The second part of the process is therefore to be thus expressed:—

$$6FeCl + 3HCl + NO_5 = 3Fe_2Cl_3 + NO_2 + 3HO.$$

LIQUOR FERRI PERNITRATIS. *Solution of Pernitrate of Iron. Pernitrate of Iron,* $Fe_2O_3\,3NO_5$ *in solution in water.*

Three fluid ounces of Nitric Acid are diluted with sixteen ounces of Distilled Water, and poured upon an ounce of fine Iron Wire, free from rust. When the metal is dissolved the solution is filtered, and as much Distilled Water added as will make its bulk a pint and a half.

According to theory Protonitrate of Iron is first formed:

$$6Fe + 8NO_5 = 6FeO,\ NO_5 + 2NO_2.$$

To convert this into Pernitrate of Iron more Nitric Acid is required. This being present the further oxidization is immediately effected, and more Nitric Oxide is evolved:—

$$6FeO,\ NO_5 + 4NO_5 = 3(Fe_2O_3,\ 3NO_5) + NO_2.$$

LIQUOR HYDRARGYRI NITRATIS ACIDUS. *Acid Solution of Nitrate of Mercury. Nitrate of Mercury, $HgO,\ NO_5$, in solution in Nitric Acid.*

Four ounces of Mercury are dissolved in three fluid ounces and a quarter of Nitric Acid diluted with three fluid ounces of Distilled Water. No heat is applied, but after the mercury is dissolved the solution is boiled gently for fifteen minutes.

Three eq. of mercury and four eq. of Nitric Acid form three eq. of Pernitrate of Mercury, and one eq. of Nitric Oxide. A large excess of Acid remains, in which the Pernitrate of Mercury is dissolved. The solution is heated to expel the Nitric Oxide which has not been evolved:

$$3Hg + 4\ NO_5 + xNO_5 = 3\ HgO,\ NO_5 + xNO_5 + NO_2.$$

LIQUOR PLUMBI SUBACETATIS. *Solution of Subacetate of Lead. Subacetate of Lead, $2PbO,\ C_4H_3O_3$, dissolved in water.*

Five ounces of Acetate of Lead are boiled with three ounces and a half of powdered Litharge for half an hour, stirring constantly: the solution is then filtered, and when cold made up to a pint with Distilled Water.

Acetate of Lead consists of one eq. of Acetic Acid and one eq. of Oxide of Lead. To obtain from this the Subacetate, another eq. of Oxide of Lead must be added:

$$(PbO,\ C_4H_3O_3 + 3\ HO) + PbO = 2\ PbO,\ C_4H_3O_3 + 3\ HO.$$

LIQUOR POTASSÆ. *Solution of Potash. Caustic Potash, KO, dissolved in water.*

One pound of Carbonate of Potash is dissolved in a gallon of Distilled Water, boiled in a clean iron vessel, and twelve ounces of Slaked Lime gradually mixed with it. It is further boiled for ten minutes, then set aside, and the clear supernatant liquid removed by a siphon.

One eq. of Carbonate of Potash is here decomposed by one eq. of Hydrate of Lime. Caustic Potash remains in solution, and insoluble Carbonate of Lime is deposited:

$$KO,CO_2 + CaO = KO + CaO,\ CO_2.$$

One hundred grains of *Liquor Potassæ* contain about six grains of Potash.

LIQUOR SODÆ. *Solution of Soda. Caustic Soda, NaO, dissolved in water.*

Twenty-eight ounces of Carbonate of Soda are dissolved in a gallon of Distilled Water, boiled in a clean iron vessel, and twelve ounces of Slaked Lime gradually mixed with it. It is further

boiled for ten minutes, then set aside, and the clear supernatant liquid removed by a siphon.

One eq. of Carbonate of Soda is here decomposed by one eq. of Lime. Caustic Soda remains in solution, and insoluble Carbonate of Lime is deposited:—

$$NaO,\ CO_2 + CaO = NaO + CaO,\ CO_2.$$

One hundred grains of *Liquor Sodæ* contain about five grains of Soda.

LIQUOR SODÆ CHLORATÆ. *Solution of Chlorinated Soda. A mixed solution of Hypochlorite of Soda, NaO, ClO, Chloride of Sodium, and Bicarbonate of Soda.*

Twelve ounces of Carbonate of Soda are powdered and dissolved in thirty-six ounces of Distilled Water, and as much Chlorine as is evolved by the action of two fluid ounces and a half of Sulphuric Acid (diluted with three ounces of water) upon four ounces of Chloride of Sodium and three ounces of powdered black Oxide of Manganese is passed into the solution. The evolution of Chlorine is furthered by heat, and the evolved gas washed by passing it through water in an intermediate bottle.

Four eq. of Carbonate of Soda are here decomposed by two eq. of Chlorine. The whole of the Carbonic Acid is appropriated by two eq. of the Carbonate, thus forming two eq. of Bicarbo-

nate of Soda. Of the remaining two eq. of Soda one gives up its Oxygen to an eq. of Chlorine and forms Hypochlorous Acid, which, combining with the other eq. of Soda, produces Hypochlorite of Soda. There remains, therefore, one eq. of Sodium, which, with another eq. of Chlorine forms Chloride of Sodium. These changes are thus expressed:

$$4\ NaO,\ CO_2 + 2\ Cl + x\ Aq = 2\ (NaO,\ HO,\ 2\ CO_2) + NaO,\ ClO + NaCl + xAq.$$

LITHIÆ CITRAS. *Citrate of Lithia.* $3\ LiO,\ C_{12}H_5O_{11}$

Ninety grains of crystallized Citric Acid are dissolved in a fluid ounce of warm Distilled Water, and Carbonate of Lithia added in successive portions, applying heat until effervescence ceases and a perfect solution is obtained. This is evaporated slowly to the consistence of a syrup, and then dried in an oven at a temperature of about 240°.

One eq. of Citric Acid here directly combines with three eq. of Oxide of Lithium, taken from the Carbonate of Lithia: Carbonic Acid is thus evolved, and basic Citrate of Lithia formed:

$$3\ LiO,\ CO_2 + \overline{Ci} = 3\ LiO,\ \overline{Ci} + 3\ CO_2.$$

MAGNESIA. *Magnesia.* MgO.

Carbonate of Magnesia, in a Cornish or Hes-

sian crucible closed loosely by a lid, is exposed to a low red heat until no portion of it, when cooled, effervesces with dilute Sulphuric Acid.

When Carbonate of Magnesia is strongly heated, it loses its Carbonic Acid, and Magnesia alone remains:—

$$MgO,\ CO_2 = MgO + CO_2.$$

MAGNESIA LEVIS. *Light Magnesia*, $Mg\ O$.

Light Carbonate of Magnesia is treated as in the next above process, and the same breaking up of the Carbonate into Carbonic Acid and Magnesia takes place here as there.

MAGNESIÆ CARBONAS. *Carbonate of Magnesia.* $3\ (MgO,\ CO_2 + HO) + MgO,\ 2\ HO$.

Ten ounces of Sulphate of Magnesia and twelve ounces of Carbonate of Soda are dissolved each in a pint of boiling Distilled Water, the solutions mixed, and the whole evaporated to perfect dryness by means of a sand bath. The residue is digested for half-an-hour with a quart of boiling Distilled Water, and the insoluble part collected on a filter, washed repeatedly with Distilled Water, and dried at a temperature not exceeding 212°.

When one eq. of Carbonate of Soda and one eq. of Sulphate of Magnesia exchange bases, the result is, theoretically, a simple Carbonate of

Magnesia. But in practice it is found that the precipitate consists of a mixture of monohydrated Carbonate of Magnesia, and binhydrated Magnesia—according to the Pharmacopeia, three parts of the former to one part of the latter. The decomposition is therefore to be thus expressed:

$4\ MgO,\ SO_3 + 4\ NaO,\ CO_2 + x\ Aq. = 3\ (MgO,\ CO_2 + HO) + MgO,\ 2\ HO + 4\ NaO,\ SO_3 + x\ Aq.$

MAGNESIÆ CARBONAS LEVIS. *Light Carbonate of Magnesia.* $3\ (MgO,\ CO_2 + HO) + MgO,\ 2\ HO.$

Ten ounces of Sulphate of Magnesia and twelve ounces of Carbonate of Soda are dissolved each in half a gallon of cold Distilled Water, mixed, and the mixture boiled for a quarter of an hour. The precipitate is collected on a filter, thoroughly washed with boiling Distilled Water, and dried at a heat not exceeding 212°.

The decomposition in this process is identical with that which takes place in the next above.

MORPHIÆ HYDROCHLORAS. *Hydrochlorate of Morphia. The Hydrochlorate of an Alkaloid,* $C_{34}\ H_{19}\ NO_6,\ HCL + 6\ HO$ *prepared from Opium.*

A pound of Opium is macerated in a quart of Distilled Water for twenty-four hours, de-

canted, and the residue again macerated with a quart of Distilled Water for twelve hours. The clear liquor is decanted, the residue strongly pressed, and the liquors mixed, evaporated on a water-bath to the bulk of a pint, and strained. To this a solution of three quarters of an ounce of Chloride of Calcium in four ounces of Distilled Water is added, and the whole concentrated so that on cooling it becomes solid. The mass is now strongly pressed, and then triturated with about half a pint of boiling Distilled Water, after which the whole is placed upon a paper filter, and the residue well washed with boiling Distilled Water. The filtrates are evaporated, cooled, and solidified as before; the mass again pressed, and if it be much coloured the process is repeated a third time—always preserving the expressed liquids. The pressed cake is dissolved in six ounces of boiling Distilled Water, and in the solution, a quarter of an ounce of purified Animal Charcoal is digested for twenty minutes; the whole is then placed upon a filter, and well washed with boiling Distilled Water. To the filtrate a slight excess of Solution of Ammonia is added, and as the liquid cools, the precipitate which forms is collected and washed with cold Distilled Water until the washings cease to give a precipitate with solution of Nitrate of Silver acidulated with Nitric Acid. This precipitate is mixed with two ounces of boiling Distilled Water,

placed in a porcelain capsule and kept hot, and as much dilute Hydrochloric Acid is cautiously added as will dissolve it. The neutral solution thus obtained is now cooled, and Hydrochlorate of Morphia crystallizes out. More crystals may be obtained by evaporation.

(The dark liquids obtained by expression as above, may be made to yield Morphia by diluting them with Distilled Water, precipitating with solution of Potash in excess, filtering, and supersaturating the filtrate with Hydrochloric Acid. To this animal charcoal is added to remove its colour, and after a second filtration Morphia is separated by adding Ammonia.)

Aqueous infusion of Opium contains Morphia, and traces of Codeine, Narcotine, and Thebaine, (combined with Meconic and Sulphuric Acids,) together with a fatty oil, extractive and colouring matter. On adding Chloride of Calcium to this infusion, the above salts are decomposed; Meconate and Sulphate of Lime are precipitated, and Hydrochlorates of Morphia, &c. are left in solution. After evaporation to dryness, the mass is pressed, by which means much of the colouring matter and extractive is separated. It is then placed in a filter, and its soluble constituents removed by washing. The filtrate will thus consist of solution of Hydrochlorates of Morphia and Codeia, with a trace of Narcotine, and colouring matter, extractive, &c. The latter are further

removed by a second and even a third evaporation of the filtrate and pressure of the mass. The cake remaining after the third pressing is dissolved in boiling Distilled Water, and should form a solution of the Hydrochlorates of Morphia and Codeia almost free from colour. To decolorize it entirely a little Animal Charcoal is added, and, after having removed this, Ammonia is employed to precipitate the Morphia. Hydrochlorate of Ammonia and Codeia are thus left in solution, and as the liquid cools, tolerably pure Morphia in crystals separates. The Morphia thus obtained dissolves readily in dilute Hydrochloric Acid, and may be crystallized from this solution.

PILULA FERRI IODIDI. *Pill of Iodide of Iron. See Ferri Iodidum.*

PLUMBI ACETAS. *Acetate of Lead.* PbO, $C_4 H_3 O_3 + 3\ HO$.

Litharge (Protoxide of Lead) is added to Acetic Acid nearly to neutralization; the solution filtered, evaporated and crystallized.

$$PbO + C_4 H_3 O_3 + x\ Aq = PbO,\ C_4 H_3 O_3 + 3\ HO.$$

PODOPHYLLI RESINA. *Resin of Podophyllum. A Resin obtained from Podophyllum by means of Rectified Spirit.*

Coarsely powdered Podophyllum is exhausted

with Spirit by percolation, and the Spirit recovered from the Tincture. The residue is slowly poured into three times its volume of Distilled Water (acidulated with one twenty-fourth of its bulk of Hydrochloric Acid), and well stirred. After twenty-four hours the deposit is separated from the clear liquor, washed with Distilled Water, and dried.

Podophyllum (the dried root of *Podophyllum peltatum*) contains two resins, one soluble in Alcohol, the other in Ether. The former is pure Resin of Podophyllin, and is precipitated from its alcoholic solution by acids: hence the directions of the Pharmacopeia to use acidulated water. Much the same product, however, is obtained by employing Distilled Water only. The Spirit must be slowly withdrawn from the tincture, and the distillation stopped when the contents of the retort become of a syrupy consistence.

POTASSA CAUSTICA. *Caustic Potash. Hydrate of Potash* KO, HO.

Solution of Potash is boiled rapidly down in a silver or clean iron vessel, until ebullition ceases, and an oily fluid remains: this is poured into moulds.

POTASSA SULPHURATA. *Sulphurated Potash. Tersulphuret of Potassium* KS_3 *with Sulphate of Potash.*

Ten ounces of powdered Carbonate of Potash and four ounces and a half of Sublimed Sulphur are mixed in a warm mortar, introduced into a Cornish or Hessian crucible, and heated, first gradually, afterwards so as to produce perfect fusion. The contents of the crucible are then poured out, kept from the air as much as possible, and allowed to solidify.

Four eq. of Carbonate of Potash and ten eq. of Sulphur are here employed. Three eq. of Potassium from the Carbonate of Potash combine with nine eq. of Sulphur, forming three eq. of Tersulphuret of Potassium; the remaining Sulphur, uniting with the three eq. of Oxygen from which the Potassium was abstracted, forms Sulphuric Acid, which, combining with another eq. of Potash forms Sulphate of Potash; and the whole of the Carbonic Acid escapes, giving rise to considerable effervescence:

$$4KO,CO_2 + 10S = 3KS_3 + KO,SO_3 + 4CO_2.$$

The fused mixture in the crucible should not be poured out until a drop of it, taken out with a glass rod, completely dissolves in water.

POTASSÆ ACETAS. *Acetate of Potash.* $KO, C_4H_3O_3$.

To Acetic Acid Carbonate of Potash is added nearly to neutralization, the liquid slowly evaporated to dryness, and then, by applying a much stronger heat, the dry mass is fused.

The Carbonic Acid of the Carbonate of Potash is here driven off, and replaced by Acetic Acid:

$$KO,\ CO_2 + \bar{A} = KO,\ \bar{A} + CO_2.$$

The only part of this process requiring especial attention is the drying, if the heat be continued too long, discoloration and partial decomposition ensue.

POTASSÆ BICARBONAS. *Bicarbonate of Potash.* $KO, HO, 2CO_2$.

Into a solution of a pound of Carbonate of Potash in a quart of Distilled Water (placed in a three-pint bottle closed at the mouth with a cork traversed by a broad tube) Carbonic Acid is introduced. The acid is evolved by the action of Hydrochloric Acid upon marble (Carbonate of Lime), in apparatus so arranged that the production of the Gas shall be moderately plentiful, and take place with regularity. It is delivered through the tube to the very bottom of the solution of Carbonate of Potash in the three-pint bottle, and continued for a week, at the end of which time crystals of Bicarbonate of Potash will have formed. These are washed and dried; and more of them may be obtained from the mother liquor by evaporating it to one half its bulk at a temperature not exceeding 110°.

In this process an eq. of Carbonic Acid directly combines with an eq. of Carbonate of Potash:

$$KO,\ CO_2 + 2HO + CO_2 = KO,\ HO,\ 2CO_2.$$

POTASSÆ CHLORAS. *Chlorate of Potash.* KO, ClO_5.

Twenty ounces of Carbonate of Potash and fifty-three ounces of Slaked Lime are mixed together and moistened with Distilled Water. These are placed in a carboy into which Chlorine (obtained by mixing black Oxide of Manganese with Hydrochloric Acid, and washed in an intermediate bottle) is introduced. When all the Chlorine evolved in the decomposition of twenty-four pints of Hydrochloric Acid of commerce by eighty ounces of black Oxide of Manganese, has come over, the contents of the carboy are removed, and boiled for twenty minutes with seven pints of Distilled Water. The solution is then filtered, crystallized, and if necessary re-crystallized.

In the first part of this process the Hydrate of Lime decomposes the Carbonate of Potash, and Carbonate of Lime and Caustic Potash result:

$$KO, CO_2 + CaO,HO = KO, HO + CaO, CO_2.$$

The Carbonate of Lime plays no further part in the process. Six eq. of Chlorine now act upon six eq. of Potash, forming five eq. of Chloride of Potassium, and one eq. of Chlorate of Potash:

$$6KO + 6Cl = 5KCl + KO, ClO_5.$$

The insoluble Carbonate of Lime being separated by filtration, the Chlorate of Potash is crystallized out, and Chloride of Potassium remains. This may be advantageously used in making Chlorate

of Potash by Liebig's method, which consists in boiling Chloride of Lime in solution (*i.e.* a mixture of Chloride of Calcium and Hypochlorite of Lime) with Chloride of Potassium, when the following decomposition takes place:

$3\,(CaO,\ ClO + CaCl) + KCl = KO,\ ClO_5 + 6\,CaCl.$

POTASSÆ CITRAS. *Citrate of Potash.* $3KO, C_{12}H_5O_{11}$.

Solution of Citric Acid is neutralized by the addition of Carbonate of Potash; the solution filtered, evaporated until a pellicle forms, and granulated.

Three eq. of Potash from the Carbonate of Potash here directly combine with one eq. of Citric Acid, setting free the Carbonic Acid:

$3\,(KO, CO_2 + 2HO) + (3HO, C_{12}H_5O_{11} + HO) + xAq = (3KO,\ C_{12}H_5O_{11}) + 3\,CO_2 + 7HO + xAq.$

POTASSÆ NITRAS. *Nitrate of Potash.* KO, NO_5.

Four pounds of Commercial Nitrate of Potash are dissolved in a quart of boiling Distilled Water, and the solution stirred as it cools. The minute granular crystals that separate are drained, and washed with cold Distilled Water, until the washings cease to give a precipitate with Nitrate of Silver.

Commercial Nitre contains traces of Nitrates of Lime and Soda, Sulphates of Lime and Potash,

and Chlorides of Potassium, Sodium and Calcium. By solution in as little boiling water as possible some of these are wholly got rid of; and, by thorough washing and crystallization, so much of the rest as to leave the Nitrate of Potash sufficiently pure.

POTASSÆ PERMANGANAS. *Permanganate of Potash.* KO, Mn_2O_7.

Three ounces and a half of finely powdered Chlorate of Potash are mixed with four ounces of black Oxide of Manganese, also in fine powder: to this mixture five ounces of Caustic Potash, previously dissolved in four ounces of Distilled Water, are added. The whole is evaporated to dryness on a sand bath, the mass pulverized, and exposed in a crucible to a dull red heat for an hour, or until it appears to be semi-fused. It is then cooled, powdered, and boiled with a pint and a half of Distilled Water. After allowing the insoluble portion to subside, the clear fluid is poured off; the residue boiled with another half pint of Distilled Water, and the fluid again decanted. The clear liquids are mixed, neutralized with dilute Sulphuric Acid, evaporated, and crystallized. The crystalline mass is now drained, boiled in six ounces of Distilled Water, and strained through asbestos. The fluid is then crystallized, and the crystals dried over Sulphuric Acid.

In the first part of this process black Oxide of Manganese (MnO_2) is oxidized at the expence of the Chlorate of Potash, and becomes Manganic Acid, (MnO_3), which, combining with the Caustic Potash forms Manganate of Potash (KO, MnO_3). On boiling the semi-fused mass, the green Manganate is changed into the crimson Permanganate (KO, Mn_2O_7), while insoluble Oxide of Manganese subsides:

$$3KO,\ MnO_3 = KO,\ Mn_2O_7 + MnO_2 + 2KO.$$

The solution now contains therefore, if the whole of the Chlorate of Potash was decomposed, Permanganate of Potash and Potash. To get rid of the latter Sulphuric Acid is added, thus forming a comparatively insoluble salt, easily separable from the very soluble Permanganate of Potash. The Sulphate of Potash is separated by means of Asbestos, as organic matter decomposes the Permanganate.

POTASSÆ SULPHAS. *Sulphate of Potash.* KO, SO_3.

One pound of "the Residue of the Process for Nitric Acid" is dissolved in half a gallon of boiling Distilled Water, and rendered neutral with Slaked Lime. The solution is filtered, and Carbonate of Potash added as long as there is any precipitate. This is separated, and dilute Sulphuric Acid added so as to produce a neutral or slightly acid solution, which is evaporated and crystallized.

The "Residue of the Process for Nitric Acid" consists of Bisulphate of Potash. Hydrate of Lime being added to a solution of this salt, Sulphate of Lime is formed, which, being almost insoluble, is for the most part deposited:

$$KO, 2SO_3 + CaO, HO + xAq = CaO, SO_3 + KO, SO_3 + xAq.$$

There remains therefore in solution Sulphate of Potash, with a very little Sulphate of Lime, which, on the addition of Carbonate of Potash is deposited as insoluble Carbonate of Lime, more Sulphate of Potash being formed:

$$KO, CO_2 + CaOSO_3 + xAq. = KO, SO_3 + CaO, CO_2 + xAq.$$

A little Sulphuric Acid is subsequently added to convert into Sulphate of Potash any excess of Carbonate of Potash that may be present.

POTASSÆ TARTRAS. *Tartrate of Potash.* ($2KO, C_8H_4O_{10}$).

Carbonate of Potash is dissolved in boiling Distilled Water, and Acid Tartrate of Potash to neutralization gradually added. After a few minutes' boiling, the solution is filtered, concentrated and crystallized.

Acid Tartrate of Potash consists of one atom of Potash and one atom of water as base, to one atom of Tartaric Acid. On the addition of an eq. of Carbonate of Potash to an eq. of Acid Tartrate

of Potash the basic atom of water is replaced by another atom of Potash from the Carbonate of Potash, which is thus decomposed, and its Carbonic Acid given off:

$KO, HO, C_2H_4O_{10} + KO, CO_2 + xAq = (2KO, C_2H_4O_{10}) + CO_2 + xAq.$

POTASSII BROMIDUM. *Bromide of Potassium. KBr.*

To solution of Potash contained in a glass vessel Bromine is gradually added, stirring constantly, until the mixture has acquired a permanent brown tint. It is then evaporated to dryness, and the residue after reducing to a fine powder, is mixed intimately with Wood Charcoal. The mixture is thrown in small quantities at a time into a red hot iron crucible, fused, and poured out. After it has cooled, it is dissolved in boiling Distilled Water; and the solution is then filtered and crystallized.

When Bromine is added (slightly in excess) to solution of Caustic Potash, Bromate of Potash and Bromide of Potassium are formed. Six eq. of Potash react upon six. eq. of Bromine:

$6KO + 6Br + xAq = KO, BrO_5 + 5KBr + xAq.$

On mixing the residue of this solution, after evaporating it to dryness, with Charcoal, and fusing, the Oxygen of the Bromate passes off with Carbon as Carbonic Oxide, leaving Bromide of Potassium alone in the crucible:

$5KBr + KO, BrO_5 + 6C = 6KBr + 6CO.$

POTASSII IODIDUM. *Iodide of Potassium. KI.*

To Solution of Potash contained in a glass vessel sufficient Iodine is gradually added to give the solution a permanent brown tint. The whole is evaporated to dryness, pulverized, and mixed with finely powdered Wood Charcoal. This mixture is thrown in small quantities into a red hot iron crucible, fused, and the mass poured out. When cold, this is dissolved, filtered, and crystallized.

The decompositions which here take place are precisely analogous to those in the process for making Bromide of Potassium. Six eq. of Potash and six eq. of Iodine form one eq. of Iodate of Potash, and five eq. of Iodide of Potassium:

$$6KO + 6I + xAq = KO, IO_5 + 5KI + xAq.$$

On fusing the Iodate of Potash with Charcoal, more Iodide of Potassium is formed, and Carbonic Oxide is evolved:

$$5KI + KO, IO_5 + 6C = 6KI + 6CO.$$

QUINIÆ SULPHAS. *Sulphate of Quinia. The Sulphate of an Alkaloid,* $C_{40}H_{24}N_2O_4, HO, SO_3 + 7HO$, *prepared from Yellow-Cinchona Bark, and from the bark of Cinchona lancifolia Mutis.*

One pound of Yellow Cinchona Bark in coarse powder is placed in a porcelain basin, and as much dilute Sulphuric Acid (B. P. strength) added to it as will render it thoroughly moist.

The maceration is carried on for twenty-four hours, after which time the bark is transferred to a percolator and exhausted by percolation with a mixture of three fluid ounces of Hydrochloric Acid and ten pints of Distilled Water. Four pints of Solution of Soda are now poured into the contents of the receiving vessel; and the precipitate is collected on a filter and washed with cold Distilled Water until the washings are colourless. It is then placed in a porcelain dish with a pint of Distilled Water, heated by a steam bath, and dilute Sulphuric Acid gradually added until very nearly the whole of the precipitate is dissolved, and a neutral liquid obtained. The solution is filtered while hot through paper, and the filter is washed with boiling Distilled Water. The filtrate (including the washings) is now evaporated and crystallized.

Quinia exists in Yellow Cinchona Bark as Kinate of Quinia. By exhausting the Bark with Sulphuric or Hydrochloric Acid the Kinate is decomposed, and a Sulphate or Hydrochlorate of Quinia formed. This is contained dissolved in the receiver of the percolator, together with Tannin, Colouring matter, Resin, and, traces of Cinchonia salts. On precipitating this solution with caustic Soda, the Quinia is deposited, and Sulphate of Soda or Chloride of Sodium remains in solution. The caustic Soda dissolves the colouring matter and the resin with which the

Quinia is associated, thus rendering them, for the most part, readily removeable from the Quinia by washing with water. On the addition to the precipitated Quinia of Sulphuric Acid, the Sulphate of Quinia is formed, and crystallizes, after evaporating its solution, in silky needles; which are not, however, perfectly white, or *entirely* free from Sulphate of Cinchonia.

SANTONINUM. *Santonin,* $C_{30}H_{18}O_6$, *a crystalline neutral principle obtained from Santonica—the unexpanded Flower-heads of an undetermined species of Artemisia. Linn.*

A pound of Santonica is boiled with a gallon of Distilled Water and five ounces of Lime in a copper vessel for an hour, strained, pressed, and the residue mixed with half a gallon of Distilled Water and two ounces of Lime, again boiled for half an hour, and again strained and pressed. The fluids are mixed, the deposit separated by filtration, and the filtrate evaporated to the bulk of two pints and a half. Sufficient Hydrochloric Acid is added now, before cooling, to render the fluid slightly and permanently acid; after which it is set aside for five days, and the oily matter on the surface is removed; then the supernatant fluid is also removed, and the deposit is collected on a paper filter. This (the deposit) is thoroughly washed, first with cold Distilled

Water, then with a mixture of half a fluid ounce of Solution of Ammonia with five ounces of Distilled Water. The washed precipitate is now gently dried, mixed with sixty grains of Animal Charcoal and nine ounces of Rectified Spirit, digested for half an hour, and boiled for ten minutes. While hot, it is filtered, the charcoal washed with an ounce of boiling Spirit, and the filtrate set aside to crystallize. The crystals first formed are re-dissolved, and the solution re-crystallized.

By boiling Santonica with Lime the latter extracts all the Santonin, holding it in solution together with a good deal of extractive, some colouring matter, &c. On the addition of Hydrochloric Acid to this solution, after concentration, Chloride of Calcium is formed, and the Santonin slowly deposited in flocks. The little etherial Oil on the surface is skimmed off, and the supernatant solution of Chloride of Calcium removed from the deposit, which consists of impure Santonin. By now washing this with Distilled Water and Ammonia, the impurities, consisting of extractive, resinous matters &c., are partly removed; Animal Charcoal further decolorizes, by dissolving the last traces of Resin, and Rectified Spirit completes the process. As it dissolves in three parts of boiling Spirit and in not less than forty parts of cold, it is readily obtained in crystals from its boiling alcoholic solution.

SCAMMONIÆ RESINA. *Resin of Scammony. A Resin, obtained by means of Rectified Spirit from Scammony Root or Scammony.*

Eight ounces of coarsely powdered Scammony Root are macerated with sixteen fluid ounces of Rectified Spirit in a covered vessel at a gentle heat for twenty-four hours, transferred to a percolator, and sufficient Rectified Spirit to exhaust it passed through. To the tincture in the receiver four ounces of Distilled Water are added; the Spirit is then recovered by distillation, and the residue removed while hot. When cold the supernatant fluid is separated from the resin, which is well washed with hot water, and dried.

Dried Scammony Root contains about four per cent of a resin identical in composition with resin of Jalap (C_{68} H_{56} O_{32}). It is entirely extracted by Alcohol, and precipitated from its spirituous solution by water. Hot water is employed in washing it to get rid of a certain volatile acid with which it is associated. Gum Scammony yields the same resin in larger proportion; as much as eighty per cent having been obtained (by the above process) from this source.

SODA CAUSTICA. *Caustic Soda. Hydrate of Soda NaO,HO.*

Solution of Soda is boiled rapidly down in a

silver, or clean iron vessel, until it will solidify on cooling.

The Soda retains at least one eq. of water. It must be boiled *rapidly* down or the product will contain some Carbonate.

SODÆ ARSENIAS. *Arseniate of Soda.* $2NaO, HO, AsO_5 + 14HO$.

Ten ounces of Arsenious Acid, eight ounces and a half of Nitrate of Soda, and five ounces and a half of dried Carbonate of Soda, (each separately rubbed into a fine powder), are mixed together and exposed in a crucible to a red heat. When effervescence has ceased and the mass is completely fused, the contents are poured out of the crucible, and, as soon as solidification has taken place, dissolved in thirty-five ounces of Distilled Water. This solution is then filtered and crystallized.

Arsenic Acid is tribasic, and forms with Soda three Arseniates, that of the Pharmacopeia being the *diarseniate*, and containing as base, two at. of Soda and one at. of water. When an eq. of Arsenious Acid and an eq. of Nitrate of Soda are fused together, the result is Monoarseniate of Soda and Nitrous Acid. To produce the Diarseniate another at. of Soda is required, which the Carbonate of Soda supplies, giving up at the

same time its Carbonic Acid. The exact composition of the fused mass is uncertain, but on dissolving this in water and crystallizing, a great deal of the water is appropriated, and the result, as described by the Pharmacopeia, is Diarseniate of Soda with fourteen at. of water of crystallization. In symbols the decompositions are represented thus:

$$As O_3 + NaO,\ NO_5 + NaO\ CO_2 + a\ Aq. = (2NaO,\ HO,\ As\ O_5 + 14HO) + CO_2 + NO_3 + x\ Aq.$$

SODÆ BICARBONAS. *Bicarbonate of Soda.* $NaO,\ HO,\ 2CO_2$.

Carbonic Acid, obtained by decomposing four pounds of Marble (Carbonate of Lime) with a gallon of Commercial Hydrochloric Acid, diluted with two gallons of water, in a proper vessel, is passed into a bottle filled with finely powdered Carbonate of Soda, through a tube which should reach to the bottom of the bottle. The Carbonate employed is a mixture of two pounds of Carbonate of Soda and three pounds of Dried Carbonate of Soda. When this absorbs no more gas, the damp salt that is formed is shaken with half its weight of cold Distilled Water, and the undissolved portion drained and dried.

Carbonate of Soda here absorbs a second eq. of Carbonic Acid, and gives up most of its water of crystallization. It is found that a carbonate of Soda containing about three or four atoms of

water answers best; hence, effloresced Carbonate of Soda (which has lost part of its water) may be employed; or, as ordered in the Pharmacopeia, a mixture of three parts of dried, and two parts of undried Carbonate. As the salt absorbs Carbonic Acid it gives up nearly all its water, and hence becomes very damp. After saturation, the washing with cold water removes all the Carbonate that may be present, and which is much more soluble than the Bicarbonate. The residue is therefore Bicarbonate of Soda, more or less pure according to the greater or less purity of the Carbonate employed. The process is thus represented:

$NaO,\ CO_2 + 4HO + CO_2 = NaO,\ HO,\ 2CO_2 + 3HO.$

SODÆ CARBONAS EXSICCATA. *Dried Carbonate of Soda.*

Carbonate of Soda is strongly heated in a porcelain capsule until the liquid which first forms is converted into a dry cake.

Crystallized Carbonate of Soda contains ten atoms of water of crystallization. By heat these are driven off.

SODÆ ET POTASSÆ TARTRAS. *Tartrate of Soda and Potash,* $NaO,\ KO,\ C_8H_4O_{10} + 8HO.$

Carbonate of Soda is dissolved in boiling Distilled Water, and Acid Tartrate of Potash added

to neutralization. The solution is filtered, concentrated, and crystallized.

In the Acid Tartrate of Potash one eq. of Potash and one eq. of water are combined as base with one eq. of Tartaric Acid. Carbonate of Soda replaces the basic water with Soda, and gives up its Carbonic Acid:

$$KO, HO, \bar{T} + NaO, CO_2 + xAq. = NaO, KO, \bar{T} + 8HO + xAq.$$

SODÆ PHOSPHAS. *Phosphate of Soda*, $2\,NaO, HO, PO_5 + 24\,HO$.

Ten pounds of powered Bone Ash and fifty-six fluid ounces of Commercial Sulphuric Acid, are well mixed together in a large earthenware basin, set aside for twenty-four hours, and a gallon of Distilled Water added. After forty-eight hours another gallon of Distilled Water is added, and thoroughly stirred in. An hour having elapsed the mixture is filtered through calico and washed with Distilled Water. The filtrate and washings are now concentrated to the bulk of a gallon, which is set aside for twenty-four hours and again filtered. The filtrate is heated to near boiling point, and then Carbonate of Soda, dissolved in rather more than its weight of Distilled Water, is added until it ceases to form a precipitate, and the fluid has acquired a feebly alkaline reaction. The whole is now filtered, and the filtrate evaporated and crystallized.

Bone Ash consists principally of basic Phosphate of Lime ($3CaO, PO_5$), with about ten per cent of Carbonate of Lime. When treated with Sulphuric Acid, and water added, Carbonic Acid is expelled, Sulphate of Lime is formed and in great part deposited, and Superphosphate of Lime is formed also, and remains in solution. The first filtrate therefore consists of solution of Superphosphate of Lime with a little Sulphate of Lime. When to two eq. of this Superphosphate of Lime ($CaO, 2HO, PO_5$) Carbonate of Soda is added until a feebly alkaline reaction is obtained, there are formed:

Subphosphate of Lime ($2CaO, HO, PO_5$) which is deposited,

Phosphate of Soda ($2NaO, HO, PO_5$) which remains in solution, and

Carbonic Acid (CO_2) which escapes.

The Sulphate of Lime is deposited by the evaporation prior to the last filtration. The reaction is thus represented:

$2(CaO, 2HO, PO_5) + 2NaO, CO_2 + xAq. = (2NaO, HO, PO_5) + (2CaO, HO, PO_5) + 2CO_2 + xAq.$

SPIRITUS ÆTHERIS NITROSI. *Spirit of Nitrous Ether. Nitrous Ether.* C_4H_5O, NO_3, *dissolved in Rectified Spirit.*

Four fluid ounces of Sulphuric Acid are mixed with two pints of Rectified Spirit and poured

upon five ounces of Nitrite of Soda in a matrass connected with a receiver, which must be kept very cool. From this mixture thirty-five fluid ounces are distilled.

One eq. of Nitrite of Soda is here decomposed by one eq. of Sulphuric Acid, Nitrous Acid and Sulphate of Soda being formed. At the same time a portion of the Rectified Spirit is also decomposed by the Acid into Ethyl and Water ($C_4H_6O_2 = C_4H_5O, + HO$) and the Ethyl combines with the Nitrous Acid to form Nitrous Ether. This remains in solution in the Spirit:

$$NaO, NO_3 + HO, SO_3 + C_4H_6O_2 + x\ C_4H_6O_2 + xAq. = C_4H_5O, NO_3 + NaO, SO_3 + xC_4H_6O_2 + xAq.$$

STRYCHNIA. *Strychnia. An Alkaloid,* $C_{42}H_{22}N_2O_4$ *obtained from Nux Vomica.*

A pound of Nux Vomica is softened by steaming it, sliced, dried, and immediately ground.

The powder is digested for twelve hours at a gentle heat with two pints of Rectified Spirit and one pint of Distilled Water, strained through linen and pressed. The residue is again subjected to the same process of digestion, straining and pressing; and then a third time. The liquors are now mixed, and the Spirit having been recovered by distillation the watery residue is evaporated to about sixteen ounces and filtered

when cold. A solution of one hundred and eighty grains of Acetate of Lead in Distilled Water is now added, so long as it occasions any precipitate. This precipitate is separated by filtration and washed with cold Distilled Water; and having evaporated the filtrate, together with the washings, to eight ounces, Ammonia in slight excess is added. After twelve hours the precipitate is collected on a filter, washed with cold Distilled Water, dried on a vapour bath, and boiled with successive portions of Rectified Spirit. These portions are mixed together, and most of the Spirit having been recovered by distillation, the residue is evaporated to the bulk of about half an ounce and set aside to cool. The solid portion which adheres to the vessel is washed with a mixture of two parts of Rectified Spirit and one part of Distilled Water until the washings cease to become red on the addition of Nitric Acid; it is finally dissolved by boiling it with an ounce of Rectified Spirit and set aside to crystallize.

The seeds of *Strychnos Nux Vomica* contain Igasaurates of Strychnia and of Brucia. These, with extractive and colouring matter, are removed by a mixture of Rectified Spirit and Water. On distilling off the Spirit and adding Acetate of Lead to the watery residue, the Igasaurates are decomposed, Igasaurate of Lead being formed, and Acetates of Strychnia and Brucia left in solution. When to this solution Ammonia is added,

Acetate of Ammonia is formed, and a mixture of Strychnia and Brucia is thrown down, which, (together with a little extractive, colouring matter, &c.,) forms in the course of a few hours a deposit. From this the Strychnia and Brucia are obtained by boiling it in Alcohol, which dissolves them. The Brucia is separated from the Strychnia by evaporating the Alcoholic solution, and setting it aside to cool, when the Strychnia forms a crust upon the vessel, leaving the Brucia in the mother liquor. The mass is freed by washing from all trace of Brucia, the absence of which is indicated when the washings are no longer coloured red by Nitric Acid. By now dissolving it in boiling Rectified Spirit and setting aside, it is obtained in prismatic crystals.

SULPHUR PRÆCIPITATUM. *Precipitated Sulphur.*

Five ounces of Sublimed Sulphur and three ounces of Slaked Lime are well mixed together; a pint of Distilled Water is added, and the whole heated to boiling. It is well stirred, boiled for fifteen minutes, and filtered; and the residue is again boiled in half a pint of Distilled Water and filtered. The filtrates are mixed, cooled, diluted with a quart of water, and dilute Hydrochloric Acid (in the proportion of eight fluid ounces of Acid to a pint of Distilled Water) is added until effervescence ceases, and the mixture acquires an acid reaction. The precipitate is separated from

the supernatant liquid, washed with Distilled Water (until the fluid ceases to have an acid reaction, and to precipitate with Oxalate of Ammonia), and dried at a temperature not exceeding 120°.

In the first part of this process three eq. of Lime and twelve eq. of Sulphur re-act upon each other, one eq. of Hyposulphite of Lime, and two eq. of Pentasulphuret of Calcium resulting:

$$3CaO + 12S + xAq. = CaO, S_2O_2 + 2CaS_5 + xAq.$$

These are both soluble, and are contained in the filtrates. On adding two eq. of Hydrochloric Acid to an eq. each of the Hyposulphite of Lime and the Pentasulphuret of Calcium, Sulphur, Sulphuretted Hydrogen, Hyposulphurous Acid, Chloride of Calcium, and Water are formed. The reactions are

(*a*) $CaS_5 + HCl + xAq. = CaCl + HS + 4S + xAq.$

(*b*) $CaO, S_2O_2 + HCl + xAq. = CaCl + HO + S_2O_2.$

As soon as the Hyposulphurous Acid is set free it resolves itself into Sulphur and Sulphurous Acid:

$$S_2O_2 = S + SO_2.$$

and on the Sulphurous Acid coming into contact with Sulphuretted Hydrogen more Sulphur is precipitated and Water formed:

$$SO_2 + 2HS = 3S + 2HO.$$

Syrupus Ferri Iodidi. *Syrup of Iodide of Iron.* *See Ferri Iodidum.*

SYRUPUS FERRI PHOSPHATIS. *Syrup of Phosphate of Iron. See Ferri Phosphas.*

VERATRIA. *Veratria. An Alkaloid,* $C_{64}H_{52}N_2O_{16}$? *obtained from Cevadilla; not quite pure.*

Two pounds of Cevadilla are macerated in boiling water, squeezed, dried, and beaten in a mortar, to separate the seeds from the capsules. The seeds are ground, made into a paste with Rectified Spirit, and packed in a percolator. Rectified Spirit is passed through the mass until what enters the receiver is colourless; the tincture is then distilled until a deposit forms, when the residue, while hot, is poured into twelve times its volume of cold Distilled Water. The whole is now filtered through calico, and the residue washed with Distilled Water until the washings cease to precipitate with Ammonia. The filtrates are mixed, and Ammonia added in slight excess; after a while the precipitate is separated from the supernatant fluid, and washed with Distilled Water until what passes through is colourless. The moist precipitate is next mixed with twelve ounces of Distilled Water, and sufficient Hydrochloric Acid added to render the fluid feebly acid. Sixty grains of Animal Charcoal are now added, and the whole is digested at a gentle heat for twenty minutes, then filtered, and cooled. Ammonia in slight excess is added lastly, and when the

precipitate has subsided, it is collected on a filter, well washed with cold water, and gently dried.

Veratria exists in Cevadilla seeds combined with a vegetable acid. This compound (Supergallate of Veratria?) together with a good deal of resin and some colouring matter is dissolved out by Rectified Spirit. When from this tincture most of the Spirit has been recovered, the residue is poured into water, which precipitates the resin, leaving the compound of Veratria in solution in the diluted Spirit. On adding Ammonia to this compound it is decomposed—Veratria being precipitated and a salt of Ammonia formed. The alkaloid is well washed with cold Distilled Water, in which it is perfectly insoluble, and then dissolved in Hydrochloric Acid, and mixed with Animal Charcoal to decolorize it. This having been filtered, the filtrate, consisting of Veratria in solution in Hydrochloric Acid, is decomposed by Ammonia, with which the Acid unites to form Hydrochlorate of Ammonia; and the alkaloid being thus set free, is precipitated.

ZINCI ACETAS. *Acetate of Zinc.* $ZnO,C_4H_3O_3 + 2HO$.

Acetic Acid is diluted with water and neutralized with Carbonate of Zinc. Heat is applied to further the solution. The liquid is filtered while hot, and set aside to crystallize.

The Carbonate of Zinc is here decomposed, its Oxide of Zinc uniting with the Acetic Acid to form Acetate of Zinc, and its Carbonic Acid escaping:

$ZnO, CO_2 + \bar{A} + xAq = (ZnO, \bar{A} + 2HO) + CO_2 + xAq.$

ZINCI CARBONAS. *Carbonate of Zinc. A mixture of Hydrated Carbonate of Zinc and Hydrated Oxide of Zinc.* $(ZnO, CO_2 + HO) + 2\ (ZnO, HO.)$

Ten ounces and a half of Carbonate of Soda, dissolved in a pint of boiling Distilled Water, are poured into a solution of ten ounces of Sulphate of Zinc also dissolved in a pint of boiling Distilled Water. After effervescence has ceased the mixture is boiled for fifteen minutes and set aside. The precipitate is separated from the supernatant liquor, well washed with boiling Distilled Water, collected on calico, strained, and dried.

According to theory the precipitate occasioned by adding Carbonate of Soda in solution, to solution of Sulphate of Zinc, should consist entirely of Carbonate of Zinc. But, as in the precipitate known as Carbonate of Magnesia, the Carbonate is associated with a great deal of Hydrated Oxide of the metal. The processes are the same, but the resulting substances somewhat differ in their composition. The Carbonate of Zinc process may be represented thus:—

$3NaO, CO_2 + 3ZnO, SO_3 + xAq.$

$= (ZnO, CO_2 + HO) + 2\ (ZnO, HO) + xAq.$

(This would be the correct explanation if the solutions were mixed cold. But if they are boiling or very hot when mixed, the composition of the precipitate is 2 (ZnO, CO_2) + 3 (ZnO, HO): $5NaO$, $CO_2 + 5ZnO$, $SO_3 + xAq. = 2$ (ZnO, CO_2) $+ 3ZnO$, $HO + CO_2 + 5NaO$, $SO_3 + xAq.$

Zinci Chloridum. *Chloride of Zinc.* $ZnCl.$

Sixteen ounces of granulated Zinc in a porcelain basin are mixed with forty-four fluid ounces of Hydrochloric Acid to which a pint of Distilled Water has been previously added. The basin is placed upon a sand bath, and a gentle heat applied until gas is no longer evolved. The mixture is then boiled for half an hour (water being added to replace that lost by evaporation), set aside for twenty-four hours, during which time it is well stirred, then filtered, and solution of Chlorine is added until the solution acquires a permanent odour of Chlorine. Carbonate of Zinc is now added in small quantities at a time and with renewed agitation until a brown sediment appears. The mixture is lastly filtered, and evaporated to solidification.

In the first part of this process Chloride of Zinc is formed and Hydrogen set free:

$$Zn + HCl + xAq. = ZnCl + H + xAq.$$

As the Zinc is associated with Iron, Protochloride of Iron is also present in solution with the Chlo-

ride of Zinc. Subsequently basic Carbonate of Zinc is added to remove the Iron, but before this can be effected the Protochloride of Iron must be converted into Perchloride. Hence the addition of Chlorine:

$$2FeCl + Cl = Fe_2Cl_3.$$

Perchloride of Iron is now decomposed by basic Carbonate of Zinc:

$$Fe_2Cl_3 + (ZnO, CO_2 + HO) + 2\,(ZnO, HO) = 3ZnCl + Fe_2O_3 + CO_2 + 3HO.$$

Thus more Chloride of Zinc is produced, Carbonic Acid is evolved, and Sesquioxide of Iron, the "brown sediment," is formed.

ZINCI OXIDUM. *Oxide of Zinc.* ZnO.

Carbonate of Zinc, in a loosely covered Hessian crucible, is exposed to a dull red heat until a portion, taken from the centre of the contents of the crucible and cooled, no longer effervesces when dropped into dilute Sulphuric Acid.

Here the Carbonic Acid and Water of the Carbonate of (Oxide of) Zinc are driven off, and the Oxide of Zinc is left in the crucible:

$$(ZnO, CO_2 + HO) + 2\,(ZnO, HO) = 3ZnO + CO_2 + 3HO.$$

ZINCI SULPHAS. *Sulphate of Zinc,* $ZnO, SO_3 + 7\,HO$.

Twelve fluid ounces of Sulphuric Acid are mixed with four pints of Distilled Water, and

sixteen ounces of granulated Zinc are dissolved in the dilute acid. The solution is filtered, and Solution of Chlorine mixed with it, gradually, and with constant agitation, until the fluid acquires a permanent odour of Chlorine. Carbonate of Zinc is now added until a brown precipitate appears: this is separated by filtration, and the clear solution is evaporated and crystallized.

In the first part of the process Water is decomposed, its Oxygen uniting with the Zinc to form Oxide of Zinc, and its Hydrogen escaping. With the Oxide of Zinc the Sulphuric Acid combines and forms Sulphate of Zinc:

$$Zn + SO_3 + xAq = ZnO,\ SO_3 + H + xAq.$$

Commercial Zinc being contaminated with Iron, Sulphate of Iron will also be present in the solution of Sulphate of Zinc. This is got rid of by decomposing it with Chlorine, and adding Carbonate of Zinc (see ZINCI CHLOR.).

ZINCI VALERIANAS. *Valerianate of Zinc.* ZnO, $C_{10}\ H_9\ O_3$.

Five ounces and three quarters of Sulphate of Zinc, and five ounces of Valerianate of Soda are dissolved each in two pints of Distilled Water, both solutions are heated to near the boiling point, then mixed and cooled. The crystals produced are skimmed off, and the mother liquor

evaporated to four ounces; and the crystals which result from the cooling of these added to those already obtained. The crystals are, lastly, drained, washed with a little cold Distilled Water, and dried.

One eq. of Sulphate of Zinc, and one eq. of Valerianate of Soda here exchange bases. The crystals first formed float, and are therefore easily separated; from what are subsequently produced, cold Distilled Water—in which Valerianate of Zinc is insoluble—removes all traces of Sulphate of Soda:—

$$ZnO,\ SO_3 + NaO,\ C_{10}H_9O_3 + xAq = ZnO,\ C_{10}H_9O_3 + NaO,\ SO_3 + xAq.$$

THE CHEMICAL SUBSTANCES OF THE MATERIA MEDICA GROUPED ACCORDING TO THEIR INTER-RELATIONS.

Most of the chemical substances of the Materia Medica may be conveniently (though not scientifically) divided into five groups:

1. *The Acids of the Pharmacopeia.*
2. *The Alkaline Salts and Preparations of the Pharmacopeia.*
3. *The Earthy Salts and Preparations of the Pharmacopeia.*
4. *The Metallic Salts and Preparations of the Pharmacopeia.*
5. *The Alkaloids and Active Principles of the Pharmacopeia.*

With the exception of some few substances (as *Sulphur*, *Iodine*, *Chloroform*, *Glycerine*, *Ether*, &c.,) which possess physical characters so definite as to render them perfectly independent, for their identification, of all chemical re-agents, the above groups contain all the substances of the Pharmacopeia that may be fairly called *chemicals*.

GROUP I.

The Acids of the Pharmacopeia.

(*a*) *Inorganic.*

Arsenious, (AsO_3). White, entirely sublimed by heat, and condensing into octahedral crystals. Its solution in water gives a yellow precipitate with Sulphide of Ammonium. All the soluble *Arsenites*, when their solution in water is acidulated, give the same precipitate with Sulphide of Ammonium.

Hydrochloric (*Solution of Hydrochloric Acid Gas, HCl, in water.*) Liquid, colourless, fuming, corrosive. Sp. gr. 1. 17. Mixed with water, Nitrate of Silver causes with it a white curdy precipitate of Chloride of Silver. All the soluble *Chlorides* give the same precipitate with Nitrate of Silver.

Nitric, ($3HO, 2NO_5$). Liquid, colourless, fuming, corrosive. Sp. gr. 1.50. Mixed with water, and poured into a solution of Sulphate of Iron, it darkens it. The *Nitrates* are characterized by evolving Nitric Acid when treated with Sulphuric Acid.

Phosphoric (*Phosphoric Acid*, $3HO,PO_5$, *dissolved in water*). Liquid, colourless, not fuming, strongly acid. Sp. gr. 1.08. Phosphoric Acid and all the soluble *Phosphates* are characterized by their solution in water forming a yellow precipitate with solution of Nitrate of Silver.

Sulphuric (HO, SO_3). Liquid, colourless, of oily appearance, very corrosive. Sp. gr. 1.840. Mixed with water it gives, in common with the soluble *Sulphates*, a heavy white precipitate with solution of Chloride of Barium.

Sulphurous (*Sulphurous Acid*, SO_2, *dissolved in water*). Liquid, with a sulphurous and somewhat astringent taste. Sp. gr. 1.04. Sulphurous Acid and the soluble *Sulphites* destroy the colour of solution of Permanganate of Potash.

(*b*) *Organic.*

Acetic (*glacial*) (*Monohydrated Acetic Acid*, $HO, C_4H_3O_3$). Liquid, colourless, pungent, very sour, fuming when in contact with Ammonia. Crystalline at 32°. Sp. gr. 1.065. Known by its characteristic acetous odour. All the *Acetates* (neutral) are decomposed and evolve Acetic Acid on the addition to them of Sulphuric Acid.

Benzoic ($HO, C_{14}H_5O_3$). In light plumose whitish crystals, with an odour of Benzoin, and a peculiar taste. Entirely sublimed by heat. Benzoic Acid is characterized by its peculiar odour when heated, and the *Benzoates* by their solutions being decomposed by the strong mineral acids, and Benzoic Acid separated.

Citric ($3HO, C_{12}H_5O_{11} + HO$). In right rhombic prisms, very soluble in water, the solution having a strongly acid reaction. Distinguished from Tartaric Acid by giving no precipitate, either

with cold Lime Water, or with solution of Acetate of Potash. When *boiled* with Lime Water both Citric Acid and the soluble *Citrates* occasion a precipitate.

Gallic ($3HO$, $C_{14}H_3O_7 + 2HO$). In acicular crystals, inodorous, soluble freely in boiling water, sparingly in cold. The solution has a sour and somewhat astringent taste. Gallic Acid and the *Gallates* give a bluish-black precipitate with a persalt of Iron. Unlike Tannic Acid, Gallic Acid gives no precipitate with solution of Gelatine.

Hydrocyanic (*Dilute.* HC_2N, *dissolved in water*). Liquid, colourless, with a peculiar odour, which may be *tasted*; volatile, transiently reddening litmus. Sp. gr. 0.997. Hydrocyanic Acid is characterized by forming Prussian Blue by the addition first of Sulphate of Iron, then of Potash, and finally of Hydrochloric Acid.

Tannic ($C_{54}H_{22}O_{34}$). Amorphous, friable, brownish-yellow, inodorous, very soluble in water—its solution acid and astringent. It is characterized by precipitating gelatine from its solution. With persalts of Iron it gives a bluish-black precipitate.

Tartaric. ($2HO$, $C_8H_4O_{10}$). In oblique rhombic prisms, freely soluble in water, and forming an acid solution. Tartaric Acid and the soluble *Tartrates* are distinguished by giving a white precipitate with an excess of Lime Water.

GROUP II.

The Alkaline Salts and Preparations of the Pharmacopeia.

(*a*) *Salts of Potash.*

Potash and its soluble salts are characterized by their solutions in water, acidulated with Nitric Acid, forming an orange yellow precipitate with Bichloride of Platinum. They also tinge purple the outer rim of flame, and give a crystalline precipitate when added to a large excess of a strong solution of Tartaric Acid.

The Salts of Potash in the Materia Medica are these :—

Acetate. (KO, $C_4H_3O_3$). White satiny deliquescent masses, very soluble in water.

Bicarbonate (KO, HO, $2CO_2$). Colourless rhombic prisms, not deliquescent, nor caustic to the taste. Very soluble in water; the solution effervescing strongly with acids.

Carbonate (KO, $CO_2 + 2HO$). In rhomboidal octahedrons, or, as usually met with in commerce, a granular crystalline powder, very deliquescent, hot and alkaline to the taste. Soluble in water.

Chlorate (KO, ClO_5). In rhomboidal crystalline plates, with a mild saline taste. Sparingly soluble in water. Explodes when rubbed with Sulphur.

Citrate ($3KO$, $C_{12}H_5O_{11}$). A granular powder, deliquescent, and soluble in water. Taste, mild and saline.

Nitrate (KO, NO_5). In six-sided prisms with striæ, soluble in water. Taste, cool and saline.

Permanganate (KO, Mn_2O_7). In prisms of a deep purple colour, very soluble in water and forming an intense purple solution, decolorized by Sulphurous Acid solution.

Sulphate (KO, SO_3). In hard short six-sided prisms, terminated by six-sided pyramids. Sparingly soluble in water.

Tartrate ($2KO$, $C_8H_4O_{10}$). In small prisms, deliquescent and very soluble in water. Taste, cool, somewhat bitter, and saline.

Acid Tartrate (HO, KO, $C_8H_4O_{10}$). Met with in commerce as a hard gritty white powder, sour to the taste, and slightly soluble in water.

Iodide of Potassium and *Bromide of Potassium*, though not salts of *Potash*, may be here described:—

Iodide of Potassium (KI). In white cuboid crystals, inodorous or nearly so, and with an acrid saline taste. Very soluble in water. Its solution is decomposed by solution of Chlorine, which liberates Iodine; and, added to a strong solution of Tartaric Acid, it gives the same crystalline precipitate as produced by salts of Potash.

Bromide of Potassium (KBr). In white cuboid crystals, inodorous, and with a pungent saline taste. Soluble in water. Its solution is decomposed by

solution of Chlorine, which liberates Bromine (readily distinguished from Iodine by *not* striking a blue colour with mucilage of Starch); it also, like Iodide of Potassium, gives a crystalline precipitate on the addition of a solution of Tartaric Acid.

Caustic Potash, or *Hydrate of Potash*, and *Solution of Potash*, behave with re-agents as already observed of the Potash salts. *Sulphurated Potash* —a compound of Sulphate of Potash and Tersulphuret of Potassium,—is characterized by its greenish-brown colour, the fetid odour of its solution in water, its potash-reaction with Bichloride of Platinum, and its sulphate-reaction with Chloride of Barium.

(*b*) *Salts of Soda.*

These are characterized by their neutral solutions in water giving a precipitate with Antimoniate of Potash. From the Potash salts they are distinguished by imparting a yellow tinge to flame, and by giving no precipitate either with Tartaric Acid or with Bichloride of Platinum.

The salts of Soda in the Materia Medica are these:—

Arseniate ($2NaO$, HO, $AsO_5 + 14HO$). In prisms, colourless, and soluble in water. In common with the soluble *Arseniates* it gives a reddish brown precipitate with Nitrate of Silver.

Bicarbonate ($NaO, HO, 2CO_2$). In rectangular prisms, or, as prepared by the Pharmacopeia process, a

white, somewhat gritty, powder. Soluble in water, forming a solution with a cool saline taste, effervescing strongly with acids.

Carbonate ($NaO, CO_2 + 10HO$). In octahedral rhombs, efflorescent and very soluble in water. The solution has an alkaline taste and effervesces with acids. It is readily distinguished from the Bicarbonate by its greater solubility, and by causing a precipitate with a concentrated solution of Sulphate of Magnesia.

Tartrate (*of Soda and of Potash.* $NaO, KO, C_8H_4O_{10} + 8HO$). In rhomboid octahedral prisms, very soluble in water, and of a mild saline taste. Its solution gives a crystalline precipitate with Sulphuric Acid ($\dot{N}aO, \dot{K}O, \bar{T} + HO, SO_3 = NaO, SO_3 + \dot{K}O, HO, \bar{T}$), but, like the Soda-salts, tinges flame yellow.

Phosphate. In rhombic prisms, efflorescent, very soluble in water, and of a saline taste. With solution of Nitrate of Silver it gives the yellow precipitate characteristic of the Phosphates.

Chloride of Sodium ($NaCl$). *Common salt, Caustic Soda, Hydrate of Soda, Solution of Soda,* and *Solution of Chlorinated Soda,* are all distinguishable from any other chemical compounds of the Pharmacopeia either by their physical characters, or by the use of the re-agents already mentioned.

(*c*) *Salts of Ammonia.*

The Ammoniacal salts and preparations are

recognized either by their peculiar pungent odour, or by the facility with which they are decomposed and give up their Ammonia on being mixed with the caustic alkalies or lime.

Acetate (NH_4O, $C_4H_3O_3$. *Solution of*). "Treated with caustic Potash it gives off an ammoniacal, and with Sulphuric Acid an acetous odour."

Benzoate (NH_4O, $C_{14}H_5O_3 + HO$). In colourless crystalline plates, soluble in water.

Sesquicarbonate ($2NH_4O, 3CO_2$). In crystalline masses with a vitreous fibrous fracture. Odour pungent, taste acrid and alkaline. Soluble in water, forming a solution which effervesces with acids.

Hydrochlorate (NH_4Cl). In crystalline fibrous masses, not of a pungent odour. Soluble in water, forming a solution of a cool saline taste.

Phosphate ($3NH_4O, PO_5 + 5HO$). In colourless prisms, becoming opaque when exposed to the air. Soluble in water.

(The *Liquor Ammoniæ fortior* of the Pharmacopeia is a solution of Ammonia in water. It contains 32·5 per cent of this gas, and has a specific gravity of 0.891.)

(*d*) *Salts of Lithia.*

The salts of Lithia are characterized by the rich crimson colour they impart to flame. Lithia stands midway between the alkali, and earth-groups, as regards both the solubility of its carbonate and the behaviour with Carbonate of Soda

of its soluble salts. Its Carbonate is less soluble than those of Potash, Soda and Ammonia, though more so than the earthy Carbonates; and although after some time it gives a precipitate with Carbonate of Soda, this precipitate is long delayed, and by no means plentiful.

Carbonate (LiO, CO_2). A white crystalline powder, soluble in cold water and effervescing with acids.

Citrate ($3LiO, C_{12}H_5O_{11}$). A white amorphous powder, deliquescent and soluble in water.

GROUP III.

The Earthy Salts and Preparations of the Pharmacopeia.

These include *Lime, Solution of Lime, Solution of Chlorinated Lime* and the *Lime-salts*, together with *Magnesia* and its salts. They are distinguished, broadly, from the alkalies, by their solutions giving precipitates with Carbonate of Soda, and from the metallic salts by their solutions, giving no precipitate with solution of Sulphide of Ammonium.

(*a*) *Salts of Lime.*

The Lime-salts are known by the white precipitate which their solutions give with solution of Oxalate of Ammonia.

Carbonate (CaO, CO_2 precipitated). A white powder, soft to the touch, insoluble in water, but dissolved, with effervescence, by the dilute Acids.

Phosphate ($3CaO,PO_5$ *precipitated*). A white powder, insoluble in water, but dissolved without effervescence, by dilute Nitric and Hydrochloric Acids.

Hydrate (CaO,HO). A white powder, slightly soluble in water. Its solution is alkaline, and has a somewhat acrid, bitter taste.

(*Solution of Chlorinated Lime* consists of *Hypochlorite of Lime, Chloride of Calcium*, and *Hydrate of Lime* dissolved in water. It is a pale yellow solution with a feeble odour of Chlorine. It decomposes solution of Iodide of Potassium, and gives the usual lime-precipitate with the Oxalates. *Saccharated Solution of Lime* is merely sweetened Lime Water.)

(*b*) *Salts of Magnesia.*

Magnesia differs from the alkalies and from Lime in being perfectly insoluble in water. The soluble salts of Magnesia are characterized by their solutions giving a white precipitate with Ammonia and Phosphate of Soda. This precipitate is a basic Phosphate of Magnesia and Ammonia.

Magnesia ("*Heavy*" and "*Light*" according to mode of preparation) (MgO). A white powder, becoming gritty after exposure to the air. Insoluble in water, soluble, *without effervescence*, in dilute Hydrochloric Acid.

Carbonate ("*Heavy*" and "*Light*," according to the Magnesia used in its preparation.) A soft white powder, perfectly insoluble in water; soluble, *with effervescence*, in dilute Hydrochloric Acid. The *Magnesiæ Carbonas* of the Pharmacopeia is a mixture of Carbonate and Hydrated Oxide of Magnesia: 3 ($MgO, CO_2 + HO$) + MgO, $2HO$.

Sulphate. (MgO, $SO_3 + 7HO$). In small prisms, very soluble in water: the solution possessing a bitter and nauseous taste.

GROUP IV.

The Metallic Salts and Preparations of the Pharmacopeia.

The solutions of these are precipitated either by Sulphide of Ammonium, or by Sulphuretted Hydrogen. In this respect they totally differ from the alkaline and earthy salts. They are divided into (*a*) *those which are precipitated by Sulphuretted Hydrogen from solutions containing a free mineral acid;* and (*b*) *those which are not precipitated by Sulphuretted Hydrogen from acid solutions, but which require Sulphide of Ammonium for their precipitation as Sulphides.* Sulphuretted Hydrogen *forms* Sulphides with these, but they are immediately dissolved by the excess of acid.

(*a*). *Metals precipitated from their acid solutions by Sulphuretted Hydrogen: Copper, Lead, Bismuth, Mercury, Arsenic, Antimony, Silver.*

1. *Salts of Copper.* Give a black-brown precipitate with Sulphuretted Hydrogen. Solutions of Copper are characterized by becoming blue, even when very dilute, with excess of Ammonia; and, when acidulated with Sulphuric Acid, by depositing metallic copper on a polished steel or iron surface.

Sulphate (CuO, $SO_3 + 5HO$). In large blue prisms, soluble in water, and with an acid reaction.

2. *Salts of Lead.* These give a black precipitate with Sulphuretted Hydrogen. They are further known by giving a white precipitate with the alkaline Carbonates, and also, but more slowly, with Sulphuric Acid; and a yellow precipitate with solution of Iodide of Potassium.

Acetate (PbO, $C_4H_3O_3 + 3HO$). In small acicular crystals forming white glistening masses. Soluble in water.

Carbonate $\{2(PbO, CO_2) + HO, PbO\}$. A white powder, insoluble in water, but soluble with effervescence in dilute Nitric Acid. This solution gives with Sulphuretted Hydrogen, and with Iodide of Potassium, the characteristic lead-precipitates.

Subacetate, Solution of ($2PbO$, $C_4H_3O_3$). A heavy liquid, clear and colourless, well characterized by "forming with mucilage of Gum Arabic an opaque white jelly."

3. *Salts of Bismuth.* These give a black precipitate with Sulphuretted Hydrogen. The most distinctive character of the compounds of Bismuth is their reduction, by the blowpipe, to the

metallic state, and the production, round the reduced metal, of yellow anhydrous Oxide of Bismuth.

The *Bismuthum Album* of the Pharmacopeia is a Nitrate of the teroxide. It is a white crystalline powder, dissolving in dilute Nitric Acid, and forming a solution which Sulphuretted Hydrogen decomposes, and which metallic Zinc reduces.

4. *Compounds of Mercury.* Solutions of compounds of the *Suboxide* of Mercury give a black precipitate with Sulphuretted Hydrogen; those of the *Peroxide*, if in excess, a brown precipitate. The insoluble mercurials (of the Pharmacopeia) are volatilized by heat.

Iodide (*Hg I*). In red scaly crystals, becoming yellow when heated. Insoluble in water, soluble in solution of Iodide of Potassium.

Subiodide (Hg_2I). A dirty green powder, "when gradually heated in a test-tube it yields a yellow sublimate, which upon friction becomes red, while a globule of metallic Mercury is left at the bottom of the tube."

Nitrate, Acid Solution of (HgO, NO_5). A colourless, heavy, caustic liquid, answering to the Nitric Acid and Mercury tests.

Oxide, (*Hg O*). Red Oxide of Mercury. In minute orange scales, soluble in Hydrochloric and Nitric Acids; insoluble in solution of Iodide of Potassium. Evolves Oxygen when heated.

Subchloride (Hg_2Cl). *Calomel.* A heavy white powder,

darkening by exposure to light. Insoluble in water, blackened by Lime Water.

Ammonio-Chloride ($NH_2 Hg_2, Cl$). "Ammoniated Mercury." A white powder, heavy, but less so than the Subchloride. Mixed with Potash it gives up its Ammonia.

Chloride ($HgCl$). "Corrosive Sublimate." In crystalline translucent masses, not very soluble in water, more so in Rectified Spirit, freely in solution of Chloride of Ammonium. With Iodide of Potassium it gives the characteristic reaction of the persalts of Mercury; with Nitrate of Silver, the reaction of a chloride.

5. *Compounds of Arsenic.* From an acid solution of arsenicals, Sulphuretted Hydrogen gives a yellow precipitate. For Arsenious Acid the tests known as Marsh's and Reinsch's are most frequently employed. The former consists in the production of Arseniuretted Hydrogen from the suspected substance together with water, *pure* zinc and *pure* Sulphuric Acid, and its conversion either into Arsenious Acid or metallic Arsenic when burned; the latter in boiling the suspected substance with bright copper-foil and dilute Hydrochloric Acid, upon which the Arsenic, if present, is soon deposited. The only arsenical compounds in the Pharmacopeia are *Arsenious Acid* (see ACIDS), *Liquor Arsenicalis*, readily identified by Reinsch's test, *Arseniate of Soda*, (see SODA,) and *Arseniate of Iron* (see IRON).

6. *Salts and Compounds of Antimony.* Sulphuretted Hydrogen throws down an *orange-red* precipitate from acid solutions of Antimony.

Oxide (SbO_3) "*Teroxide.*" A white powder, tasteless, insoluble in water, soluble in solutions of the caustic alkalies and in Hydrochloric Acid.

Terchloride ($SbCl_3$ *Solution of*). A yellowish brown liquid, immediately decomposed if poured into water, and forming thus a white precipitate which is changed to orange-red by Sulphuretted Hydrogen.

Sulphuret {*with a little Teroxide* ($SbS_3 + xSbO_3$).} "*Golden Sulphuret of Antimony.*" An orange-red, light powder, soluble in alkaline solutions and in Hydrochloric Acid.

Tartrate {*with Tartrate of Potash* ($SbO_3\,KO$, $C_8H_4O_{10} + 2HO$).}. In white crystals, having a nauseous metallic taste, and soluble, but not very freely, in cold water. Like the tartrates it is blackened by heat, and it behaves with Sulphuretted Hydrogen as an antimonial.

7. *Salts of Silver.* Solutions of these give a black precipitate with Sulphuretted Hydrogen. Their most characteristic reaction is the production of Chloride of Silver in a white curdy precipitate when solutions of them are mixed with solutions of the soluble chlorides. Chloride of Silver blackens by exposure to light.

Nitrate (AgO, NO_5). In laminar rhomboidal crystals,

soluble in water, forming a solution which stains the cuticle.

Oxide (*Ag O*). A brownish powder, insoluble in water, perfectly soluble in Nitric Acid, and forming a solution which, on evaporation, yields crystals of Nitrate of Silver.

(*b*) *Metals not precipitated from their acid solutions by Sulphuretted Hydrogen, but which require Sulphide of Ammonium for their precipitation. Aluminium, Zinc, Iron.*

1. *Aluminium.* The Salts of Alumina, (Oxide of Aluminium,) give a gelatinous whitish precipitate with Sulphide of Ammonium. This, however, is not a Sulphide, but the Hydrate of Alumina. The gelatinous character of this precipitate, and its solubility in solution of Potash, sufficiently characterize it.

   The only alumina-compound of the Materia Medica is *Alum*, described as *Sulphate of Alumina and Potash*, Al_2O_3, $3SO_3 + KO$, SO_3, $+ 24HO$.

2. *Salts of Zinc.* Sulphide of Ammonium throws down a white precipitate from solutions of the zinc-salts. Solutions of the alkalies cause a white precipitate, soluble in excess of the precipitant. Carbonate of Ammonia also precipitates, and dissolves the precipitate, but the precipitate caused by the Carbonates of Potash and Soda are *not* soluble in an excess of the precipitant.

Acetate (*ZnO*, $C_4H_3O_3$ + 2*HO*). Light pearly crystals with a styptic taste, and soluble in water.

Carbonate {*A mixture of Carbonate and Hydrated Oxide*, (*ZnO*, CO_2 + *HO*) + 2 (*ZnO*, *HO*).}. A white tasteless powder, insoluble in water; soluble, with effervescence, in dilute Sulphuric Acid.

Chloride (*ZnCl*). A deliquescent caustic salt, usually in fused sticks, soluble, but not perfectly, in water.

Oxide (*ZnO*). A white, tasteless powder, insoluble in water, soluble, *without effervescence*, in dilute Sulphuric Acid. Oxide of Zinc becomes yellow when heated.

Sulphate (*ZnO*, SO_3 + 7*HO*). In colourless prisms, with a peculiar styptic taste. Soluble in water.

3. *Salts and Compounds of Iron.* With Sulphide of Ammonium the soluble *proto*-Salts of Iron give a dark dirty green precipitate. They are also precipitated by Ferrocyanide of Potassium, which throws down a substance first white, afterwards blue; Ferricyanide of Potassium throws down at once a blue precipitate. The *per*-salts of Iron give a black precipitate with Sulphide of Ammonium; a blue with Ferrocyanide of Potassium, and a blue-black with Tincture of Galls. All these precipitates are immediately produced.

Arseniate (3*FeO*, AsO_5). A greenish amorphous powder, insoluble in water, soluble in Hydrochloric Acid. Its solution in Nitric Acid answers to the tests for the protosalts of Iron, and is known for that of an Arseniate by giving a

precipitate with Acetate of Lead, which, when strongly heated, evolves the garlicky fumes of Arsenic.

Carbonate (FeO, CO_2) *Saccharated.* Greyish-brown, amorphous, soluble with effervescence in dilute Sulphuric and Nitric Acids.

Citrate {*of Iron and of Ammonia.* (Fe_2O_3, NH_4O, HO, $C_{12}H_5O_{11} + 2HO$)?}. In reddish brown scales, very soluble in water. Soda decomposes it, forming with its acid, Citrate of Soda, evolving Ammonia, and depositing Peroxide of Iron. It is distinguished from the *Tartrate of Iron and Potash*, by this "alkaline solution" (Citrate of Soda) giving no crystalline deposit when slightly supersaturated with Hydrochloric Acid.

The *Citrate of Iron and Quinine* is readily known by its greenish-yellow scales, which, when properly made, are readily soluble in water.

Iodide (FeI, + $4HO$). Crystalline, of a dingy green colour, very deliquescent, and soluble in water. With Ferricyanide of Potassium it gives the reaction of the proto-salts of Iron, and, like all the soluble Iodides, is decomposed by Chlorine.

Oxide. There are three oxides of Iron mentioned in the Materia Medica: *Peroxide* (*monohydrated*, Fe_2O_3, HO; and *Sesquihydrated*, $2Fe_2O_3$, $3HO$) and *Magnetic Oxide*, a mixture of Peroxide of Iron, Protoxide of Iron, and water. The monohydrated peroxide is a brown powder, the sesquihydrated peroxide a reddish-brown paste, the magnetic

oxide a blackish powder. Each is tasteless and soluble in dilute Hydrochloric Acid, forming solutions easily identifiable by the tests already named.

Perchloride (*Solution of*, Fe_2Cl_3). A reddish-brown heavy liquid, nearly inodorous, with a very astringent taste.

Pernitrate (*Solution of*, Fe_2O_3, $3NO_5$). A reddish-brown liquid, considerably lighter in colour than the next above; nearly inodorous, with an astringent taste.

Phosphate ($3FeO$, PO_5) "*partially oxidated.*" A slate-coloured powder, insoluble in water, soluble in Hydrochloric Acid. The solution answers to the tests for the salts both of the *Protoxide* and of the *Peroxide* of Iron, and also to those for the phosphates.

Sulphate (FeO, $SO_3 + 7HO$). Crystalline, in rhombic prisms, of a green colour, inodorous, soluble in water.

Tartrate (*with Tartrate of Potash*, Fe_2O_3, KO, $C_8H_4O_{10} + HO$). In dark red scales, of a sweetish taste, and soluble in water. It may be distinguished at once from the *Ammonio-Citrate of Iron*, which it resembles, by evolving no Ammonia on being boiled with Solution of Soda.

GROUP V.

The Alkaloids and Vegetable Active Principles of the Pharmacopeia.

(The Alkaloids differ from the Active Principles in forming definite compounds with acids. No attempt at a scientific classification is here made; the object is merely to show how the identity of each may be established by its behaviour with re-agents).

The *uncombined* Alkaloids are :—

1. *Aconitia.* Amorphous, nearly white, soluble in 150 parts of cold water, forming a solution with an alkaline reaction. "A diluted solution of it is precipitated by Tincture of Iodine, Tincture of Galls, and the Chlorides of Gold and Mercury, but not by Chloride of Platina" (Pereira.) It irritates the nose, but does not excite sneezing.
2. *Veratria.* An amorphous, pale brownish-white friable mass, insoluble in water, and a powerful irritant of the nostrils, causing excessive sneezing. Heated with dilute Sulphuric Acid it becomes of a rich crimson colour.
3. *Atropia.* Crystalline, in prisms, soluble in 300 parts of cold water. Its solution has an alkaline reaction, is precipitated by the Chlorides of Gold and of Platinum, and reddened by Tincture of Iodine. "Nitric Acid dissolves it, forming a *yellow solution*: it is also soluble in cold Sul-

phuric Acid without colour; but if heat be applied the mixture acquires a red colour."

4. *Strychnia.* Crystalline, in white glistening crystals, not very soluble in water. Its solution has an intensely bitter taste, and an alkaline reaction. Strychnine is characterized by its behaviour with Sulphuric Acid and Bichromate of Potash. When a crystal of it has been dissolved in a drop of strong Sulphuric Acid, Bichromate of Potash produces first a blue, then a violet, then a red, and lastly a yellow colour.

The *combined* Alkaloids of the Pharmacopeia are:—

1. *Bebeeria. Sulphate of.* In brown scales, resembling some of the double salts of Iron. Soluble in water, forming a very bitter solution.
2. *Morphia. Hydrochlorate of.* Crystalline, in silky prisms soluble in water, reddened by Nitric Acid, and turned blue-green by tincture of Perchloride of Iron. Its solution in water is not tinged with blue, it gives the usual chloride-reaction with solution of Nitrate of Silver, and it is coloured brown, or reddish-brown by Iodic Acid.
3. *Quinia. Sulphate of.* Crystalline, in white silky needles, sparingly soluble in water, readily in water acidulated with Sulphuric Acid. Its solution has a peculiar blue tint, and gives a precipitate with solution of Chloride of Barium.

The Active Principles (vegetable) of the Pharmacopeia are:

1. *Digitalin.* In small amorphous friable masses, nearly white, and a powerful irritant of the nostrils. It is soluble in 2000 parts of cold water; dissolved and turned green by Hydrochloric Acid, and first blackened, then turned red, by strong Sulphuric Acid.
2. *Santonine.* Crystalline, in colourless rhombic prisms, somewhat flattened. Exposed to the sunlight it becomes yellow. It is almost insoluble in water.

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